Engineering Record

A Weekly Journal Devoted to Civil Engineering and Contracting

Published by McGraw Publishing Company, Inc.

Volume 72 NEW YORK, SATURDAY, OCTOBER 16, 1915 Number 16

Form of Valuation Report

GENERALIZATIONS as to the form of report to be made by the Division of Valuation of the Interstate Commerce Commission in connection with the evaluation of the carriers were presented at the conference in Washington last May. Further discussion of this important phase of the Government's gigantic undertaking appears in the brief recently filed by the railroads with the commission, although the subject was not reached at the conference two weeks ago. Mr. Jurgensen of the Minnesota Railroad and Warehouse Commission now offers on page 484 something tangible in the shape of forms which aim to record valuations on all of the various conflicting bases advocated, with or without depreciation, overhead and the like. The Engineering Record understands Mr. Jurgensen to be one of those who favor deducting everything deductible, and suspects that his valuation will be found in column 18 of the main sheet. One very apparent flaw in his attempt to show the claims of all interests is his failure to mention property used but not owned by the carrier. The forms should, however, serve as a basis for discussion, and are submitted for that purpose.

More Speed Records

THE Sheepshead Bay Speedway near New York City, the only track of its type in this country with scientifically designed curving banks on the turns, has proved to be the fastest in the world. On Sept. 18 a world's record of 5 min. 32 4-5 sec. for 10 miles, which is a rate of 108 miles per hour, was made. In the Astor Cup race on Oct. 9, the winner covered 350 miles in 3 hours 24 min. 42 sec., a rate of 102.6 miles per hour, another world's record for this distance. A crowd variously estimated at between 60,000 and 97,000 people witnessed the latter race, and found ample accommodations in the steel-frame grandstand and the timber bleachers, described in this journal Oct. 2. Incidentally, it can be stated in connection with a recent editorial criticising the track design for omitting clips to hold the timber surface, and a letter from one of the engineers stating that they were to be used, that these clips were replaced by using nails driven into the underside of the flooring and bent over the top flanges of the I-beam supports.

Safety in Steel Erection

WHAT may be done in the way of safeguarding the public and the workmen on steel erection is strikingly illustrated by the record of more than 6000 tons of steel erected at a rapid rate over congested streets without a serious accident, made on section 1 of the Manhattan elevated railway improvements in New York City, described elsewhere in this issue. This section is in the badly-crowded streets of the downtown jobbing district, where street-car, truck and pedestrian traffic is very dense. Nets hung beneath the structure under repair protected the street traffic from falling objects, a most fruitful source of accidents. All excavations for new column footings were carefully guarded. The elevated tracks themselves were at all times kept in first-class operating condition. The new steel, brought in by truck, was safeguarded when left on the street, and handled with skill when being moved. The rigging was done successfully, although the conditions were anything but favorable for safe rigging. This performance stands in sharp contrast to the unfortunate records for accidents made in erecting the frames for the two largest office buildings in the world, the Barr Building in St. Louis, and the Equitable Building in New York City, although the conditions on building erection, where the public can be largely excluded from the danger zone, are usually considered favorable for a low accident rate. The record of the elevated work shows plainly what can be done by a competent erector with skilled forces toward making a hazardous construction operation safe.

Chicago's Garbage Problem

IT is doubtful if the present city officials in Chicago will have the audacity to turn back any part of the garbage disposal plant to private parties. The widespread publicity which this subject has received indicates that the investigations by experts have so educated the editorial writers that they will keep their readers informed correctly just as soon as any attempt is made to put the money-making end of the problem ahead of service. After the health commissioner has finished his personal investigations of plants in other cities it may be that he will abandon his opinions as to remedies, namely, to separate the garbage reduction problem into two parts—the money-making end to go to a private contractor, who may or may not carry out the work in a sanitary manner, and the city to hold to that part of the process which provides most of the political jobs. More than $700,000 has been expended on the plant to date and more than $300,000 is estimated as an amount necessary to complete it. Why not put up the money and finish the plant before talking about deficits? The newspapers want experts to report on the possibilities of improvements under a business-like management, and they further ask that the report of the city waste commission, made two years ago, be restudied to see how nearly the recommendations of that document have been carried out. The local engineering societies in Chicago ought to endorse this plan and show their approval, if nothing else, for it is exactly what they would recommend. A few cities are able to handle garbage without mixing sufficient politics to make the process more noisome than it must be anyway. Chicago has a chance to do excellent pioneer work along this line, but she must turn the problem over to experts whose hands are not tied politically.

Large Contractors in Road Work

ONE noticeable effect of the stagnation in engineering construction is the extent to which large and financially strong contractors are entering the highway field. Formerly road work was done almost entirely by small "outfits," one-man organizations, which either specialized in road work or engaged in a variety of small engineering—small sewer, waterworks, drainage and bridge work. Now names which are powers in the big contracting world—builders of railroads, dams, huge water supply and sewerage works—will be found among the bidders for highway contracts. It is true in the East and in the Middle West. Moreover, while scarcity of work in other lines has brought these companies into the highway field, it is likely that they will withdraw only to a minor extent when big work is plentiful. Conference with the contractors and the equipment manufacturers indicates that they are in the field to stay. They are stocking up with road-building plant and are putting good men on the work for the purpose of educating them to the best methods. This development, the Engineering Record believes, is in the direction of highway progress. The engineers favor it. With more responsible contractors and more competent organizations lower costs and better work are assured. This does not mean that among the veteran small road contractors there were not competent men. As a class, however, they needed close watching, often lacked competence, and depended more on political influence than on good work to save themselves from serious trouble with the engineers.

Graphical Versus Analytical Methods

ALTHOUGH the question whether to use graphical or analytical methods of computation and analysis is often determined almost wholly by the personal preference of the engineer and his familiarity with the general procedure in the one case or the other, there are certain problems for which the graphical method is inherently superior.

For example, the external reactions for all cases of beams and arches supporting oblique loads can be more directly obtained by graphical diagrams. Further, the great advantage of influence lines for exact analysis in determining that position of live loading which will give maximum stresses at given sections is particuarly evident in the analysis of indeterminate structures. The two articles by C. S. Whitney, one on page 324 of the issue of Sept. 11 on the fixed-end arch, and the other on page 486 of this issue, in which application is made to the reinforced-concrete conduit solved by Mr. Smith in the issue of May 22 by the method of least work and trial graphical diagrams, demonstrate the possibilities of purely graphical methods in both speed and accuracy. This journal agrees with Mr. Whitney's contention that, especially in the case of conduits in deep earth fill, the external loading is not known within wide limits, and that temperature effects are also largely indeterminate. Further, the assumed fixed ends in arch analysis are never absolutely rigid and unyielding. Refinements in accurate analysis are wholly unjustifiable for such problems. Mr. Whitney has checked the results of his graphical methods with analytical values within small percentages, indicating the possibilities of the graphical diagrams. If larger spans and loading occur, so that graphical methods become inadequate, the summations in his equations can easily be made analytically instead of using force and equilibrium polygons. The chief advantage of his method is the entire elimination of all trial polygons and trial lines in the graphical analysis. A similar method has been used for some time in Germany, and the obvious superiority of this analysis in directness and simplicity should commend itself to engineers in this country.

A Recipe and a Remedy

TAKE about 500 men from eight or nine adjacent States, dip them in the lore of road work, bring them together as delegates to a convention, season them with a number of papers which overlap in thought and are general in character, allow the whole to simmer for three days, and you have the recent Northwestern Road Congress. In justice to the convention it should be mentioned that a slight amount of seasoning was added in the form of short to-the-point talks by several speakers, but the papers were mostly of such a general nature that there was practically no discussion. Too much time was allotted to each speaker. As a result the entire schedule was blocked and many of the papers were not read.

The Northwestern Road Congress, and, for that matter, many other conventions of a similar nature could well afford to adopt the scheme followed by the National Council of Safety at its conventions, where the red and green electric light signal system for speakers is used. The speaker is allotted a certain time and about 4 min. before its expiration the green light on the chairman's table is turned on, flashing a warning to the orator to start his concluding remarks. At the expiration of the time limit the red light glows its message, "Stop." This has a fourfold effect. It does away with rambling reminiscences by the speaker; it keeps him hard at it driving home the points he wishes to make; it is a useful guide for those in the audience who are waiting for other papers, and it gives backbone to the average chairman, who hesitates to cut short a prominent speaker who has exceeded his time.

Will the time ever come when papers of a general nature will be tabooed at conventions where men go to get pointers and new methods? The symposium idea, where a number of men give their experience and advice on a single phase of any particular kind of engineering, would prove of value to those present and would render the convention proceedings of any organization a valuable addition to technical literature.

Are Engineers Becoming More Practical?

WHETHER the intellectual stimulus of the world, induced by the war, is affecting the engineer in the same way that it is affecting the general public is a problem impossible to solve in definite terms, but there are indications that engineers are sensitive to present-day conditions. Public library withdrawals indicate that the materialistic, commercial subjects bearing on economics are being studied as never before. Theodore H. Price, in the October *World's Work*, verifies these conclusions at the Chicago and New York libraries, where the largest demands are now along immediately practical rather than academic lines. "In its genesis," says Mr. Price, "the struggle was inspired by a desire for commercial dominion and, in its progress, it has become a test of economic endurance. It is quite logical, therefore, that it should bring commercial and economic subjects into the foreground and set people to thinking how they can repair the waste of the war while it lasts, profit by the commercial opportunities it offers, and pay the debts incurred when it is over."

It was reasonable to suppose that the engineer would respond to this stimulus to a much greater extent than would the layman and the following indications are that he has done so. As applied to himself the engineer in Chicago and elsewhere is beginning to support the newly formed material welfare organization, the American Association of Engineers. In fifteen days fifty-four men, including a past-president of two National societies, several consulting engineers and contractors of note, became members. The Western Society of Engineers recently devoted a whole evening to the discussion of the material welfare of its members.

From the general standpoint the papers read at the International Engineering Congress in San Francisco are a good criterion. John F. Stevens linked business principles with government railroads as a necessity. F. H. Newell discussed the question "Does Irrigation Pay?" and Logan Waller Page chose as his subject "Economic Factors All-Important in Rural Highways." Prof. George F. Swain urged still more practical methods in teaching engineering.

With the intensive, materialistic and economic pressures brought to bear on the European belligerents they have become more or less socialized in so far as their economic resources are concerned. This tendency is sure to spread when the war is over. It is, therefore, a good time for engineers, for their own welfare as well as for that of their country, with their training in organization and the economics of material things, to turn their energies more than ever into the larger spheres of citizenship. More engineers should become city managers and members of civic boards. When positions which call by statute for engineers are not filled from the ranks of technical men, as is now the case in Chicago, engineering societies are obligated to protest most emphatically, and, if need be, to start injunction proceedings against the city treasurer enjoining him from spending the taxpayers' money for salaries of unqualified men. Individual efforts would be futile. Co-operation is absolutely necessary to secure results in such cases.

Why the New York Subway Decking Collapsed

IN discussing the two recent subway construction accidents in New York the daily press has set forth many choice bits of reasoning in explanation of the collapse of the street decking described in the Engineering Record of Sept. 25 and Oct. 2. These arguments agree only in the matter of reflecting on the engineering profession. As told to the coroner's jury, the story of the blasting foreman, who said he removed several small pieces of blocking near the heading before firing the fatal blast, has been seized on as a complete explanation of the collapse on Seventh Avenue by a zealous Brooklyn editor, who asks why the engineers failed to discover, amid the general wreckage, that this blocking had previously been in place and had been removed before the blast was fired. The report of the commissioner of accounts of New York City, made to the Mayor, has been widely exploited because it scores the type of street support used on the sections affected as "entirely unsuited for the purpose for which it was designed." Nevertheless, of the three sections where this type of timbering was used, 36 per cent of all work on one, 42 per cent on another and 65 per cent on the third—the section where the worst collapse occurred—had been completed on Sept. 1. This means that the "unfit" street support had actually supported the streets over these sections for the greater part of the excavation required on them.

It is easy to condemn a system of construction after it has failed. This journal was able to do that in pointing out editorially, in advance of the daily press and the reports of various investigating bodies, the need for more X-bracing in the structure which failed. The public is even now blaming the engineers—and justly—for not having foreseen and forestalled this accident. To do this latter is much more difficult, and that it has been done successfully on the great majority of the subway sections now being built is agreed by all the reports yet made public by competent investigating bodies.

The point about the accident on Seventh Avenue overlooked by the commissioner of accounts, the press, and so far by the coroner's investigation, and pointed out in this journal at the time of the accident, is the fact that the car which fell into the cut had no business where it was, and that its weight undoubtedly contributed to the extent of the collapse. Whether the fault was that of the blasting foreman, of the motorman, of the flagmen, or of general practice, it was criminal negligence to allow a car full of passengers to stand over a section of street on temporary supports while a blast was being fired beneath. It is well to talk of what engineers may do to prevent accidents of this sort, but it must be remembered that the very existence of a red flag block about a zone where a blast is being fired is proof that such work entails risk, however slight that risk may be made. Entirely aside from the safeguards the engineers may be able to provide, the city officials, the press and the public have it within their power to protect the public from personal injury and loss of life resulting from blasting accidents by demanding red flags blocks of the proper extent when such work is being done, and by seeing that proper attention is paid to them.

More Engineers Wanted for Federal Valuation

ANNOUNCEMENT was made last week in the "News of the Week" of this journal that a new set of non-assembled examinations would be held for the senior technical positions, grade 2 only, on the Federal valuation work. The Division of Valuation, recognizing the magnitude of its task and the certainty of adverse criticism if the work should be entrusted to incompetent men, has proceeded carefully and slowly with the organization of its forces. At present there are about 875 engineers in the work. Men who passed the 1913 examinations and have not been called to duty need not think that there is no chance for them. The regulation does, however, stipulate that eligibility lists shall expire after one year unless extended by the Civil Service Commission, and while the 1913 lists have heretofore been so extended it is likely that they will now be allowed to expire. Therefore every man on the list who still desires to get into the work and considers himself well qualified would do well to take the examination again and strive to obtain a higher rating.

New and old applicants alike should remember that in non-assembled examinations of this character the examiners must necessarily depend almost entirely on the candidate's own story. While the Division of Valuation can easily run down false claims when making its selections from the certified lists, the original examiners cannot be expected to fill the gaps left by too modest applicants who have failed to tell of their achievements. It has been suggested that some of those who were disappointed in their ratings two years ago may have taken too much for granted and failed to give specific information. Titles, especially in railway service, mean little. Division engineers on some roads have maintenance only, on others construction only, on still others both. Assistant engineers may be anything from high executives to senior draftsmen. Work done is far more significant than titles held. Attention is called to a paragraph that appears in each announcement:

"Great care should be taken to make the statements in the application form complete and correct in all details, as no additional or amended statements will be accepted by the commission that have not been received within thirty days after the date of the examination. Applicants should state fully all experience having any bearing on their qualifications for the position, although part of it may be of a character not herein mentioned. Especial weight will be given to experience in valuation and unit cost work."

In this connection it is suggested that certain information of a non-technical nature is not without value to the examiners. If an applicant has bought land, or administered an estate, or managed a business, he should record that fact.

If a man is about equally qualified in two or three lines it is not necessary for him to choose which examination to take. He should take all for which he is qualified. He might, for instance, try for civil engineer, structural engineer and architect, and qualify for all three. Of course, a wild attempt to get into the service somewhere by trying all of the examinations would only stamp a man as a jack of all trades and master of none, but genuine qualifications in two or three lines would doubtless enhance his general value. The Division of Valuation wants broad men, with good perspective and balance.

As the applications must be in by Nov. 2 it behooves all who mean to apply to get at it at once.

Depth of Trickling Filters and Its Relation to Efficiency

EXPERIENCE with sewage trickling filters of different depths has shown that deep filters are relatively more efficient than shallow filters. A filter 10 ft. deep, for example, can be operated at a rate considerably more than double that of a filter 5 ft. deep and made to yield as good an effluent. In some cases doubling the depth has increased the rate of efficiency as much as five times. For some time this has been a puzzle to sanitary engineers, but the true explanation seems to have been given by H. W. Clark, director of the division of water and sewage laboratories of the Massachusetts State Department of Health. In a paper presented to the sanitary engineering section of the American Public Health Association at its recent meeting in Rochester and printed on page 477 of this issue, he explained that the phenomenon is one resulting from the laws of hydraulics; it is a physical, not a chemical or a biological matter.

In any filter some of the liquid courses through the main channels in a relatively short time, while part of it is held in the smaller channels because of increased friction and capillarity, and thus takes a longer time to pass from the top to the bottom. In any filter the effluent is a mixture of liquids that have passed quickly and those that have passed slowly—that is, a mixture of liquids scantily purified with liquids well purified. By dosing beds with salt Mr. Clark found that in the shallow filters there was a much larger proportion of the liquid which had passed the filter rapidly. In one experiment it was found that 50 per cent of the salt applied appeared at the outlet and mingled with the effluent in 12 min. in the case of a 5-ft. filter, but that in a 10-ft. filter of the same material operating at the same rate it took 1¾ hours for an effluent containing 50 per cent salt to reach the underdrains. In various other ways experiments were made to establish the point.

This idea is not new in filtration. It was studied in the early days of the Lawrence Experiment Station, but appears to have been lost sight of. It is more important in beds of coarse material, like trickling filters, than in fine sand beds.

The subject opens up some interesting topics for discussion. Filter effluents must be regarded as composite liquids, as mixtures of large proportions of waters thoroughly purified with small proportions of waters purified less thoroughly. The efficiency is a measure of the ratio of the one to the other. That there must be differences between coarse sands and fine sands in this respect is obvious, and it is also obvious that it is the finer particles of the sand filling in the spaces between the larger grains that determines the time of percolation and, accordingly, the rate of mingling of the current threads within the filter. It was for this reason that the effective size of filter sand was established near the lower sizes of the constituent grains instead of at the size of the median grain. In the case of trickling filters no effort has been made to control the time of percolation except by altering the depth and the limiting sizes of the grains. Perhaps the ideas represented by the terms "effective size" and "uniformity coefficient" connot be applied to broken stone, but it would be well to have this subject more carefully studied.

If a filter effluent is a composite of small volumes of liquids imperfectly filtered with large volumes perfectly filtered, wherein does this differ from the dilution of raw sewages with clean river water? That there are some differences is obvious, the larger particles of suspended matter being completely removed in the one case and not in the other; but what about bacteria and dissolved organic matter? There are important questions here involved which the opponents of the dilution method would do well to consider. Mr. Clark's paper should stimulate anew the interest in the physical problems of water and sewage purification as well as the relations between hydraulics and the chemical and biological processes in purification plants of all kinds.

Section of New York Elevated Rebuilt Under Heavy Traffic Without an Accident

Complicated Layout Made Planning of Erection Difficult—Top Flanges Removed to Set Girders—Close Quarters Required Special Rigging

DURING the eleven months prior to September the elevated lines centering at Chatham Square in New York City have been entirely rebuilt at a uniformly rapid rate to accommodate a new and enlarged track layout. This work involved placing 6076 tons of steel, and was done without holding up a single train on these lines, which were operated on 90-sec. headway, without killing or seriously injuring a single workman or a single passer-by in this congested district, and without delaying street traffic at any time more than 18 min. The highest tonnage of steel set in any one month was 1159 tons placed in June, 1915.

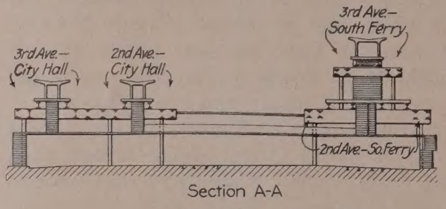
This part of the Manhattan elevated improvements, known as section 1, included some of the heaviest and most difficult replacement work of all the New York elevated improvements. At Chatham Square the Second and Third Avenue elevated lines come together, and extend south in two branches, one to South Ferry and one down Park Row to Brooklyn Bridge. Section 1 includes the elevated lines for a short distance above Chatham Square on the Bowery, and the lines below Chatham Square on Park Row to the end of the line at Brooklyn Bridge, and on the New Bowery and Pearl Street to the Franklin Square Station.

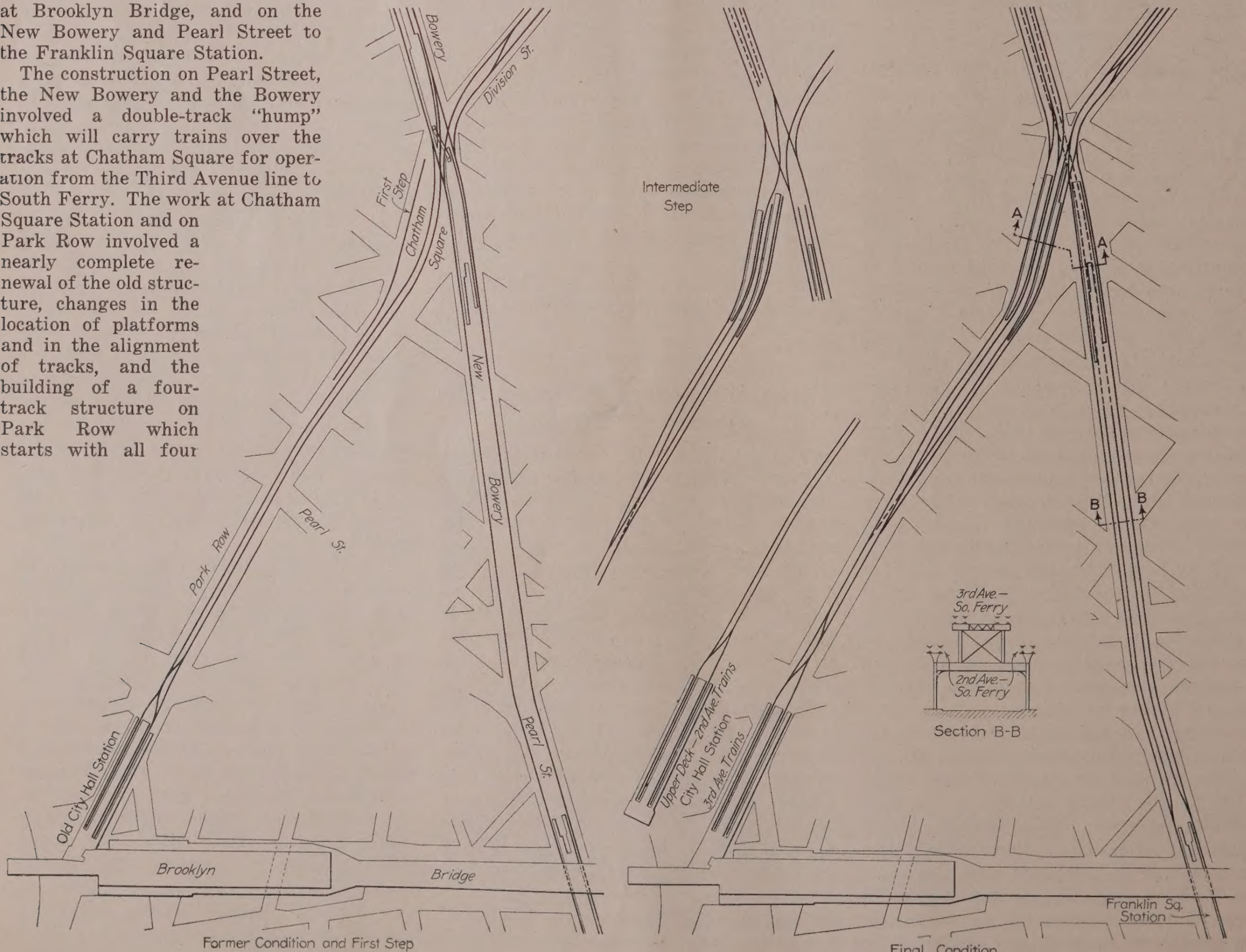
The construction on Pearl Street, the New Bowery and the Bowery involved a double-track "hump" which will carry trains over the tracks at Chatham Square for operation from the Third Avenue line to South Ferry. The work at Chatham Square Station and on Park Row involved a nearly complete renewal of the old structure, changes in the location of platforms and in the alignment of tracks, and the building of a four-track structure on Park Row which starts with all four tracks at grade and ends at Brooklyn Bridge in a double deck.

ORDER OF CONSTRUCTION CAREFULLY PLANNED

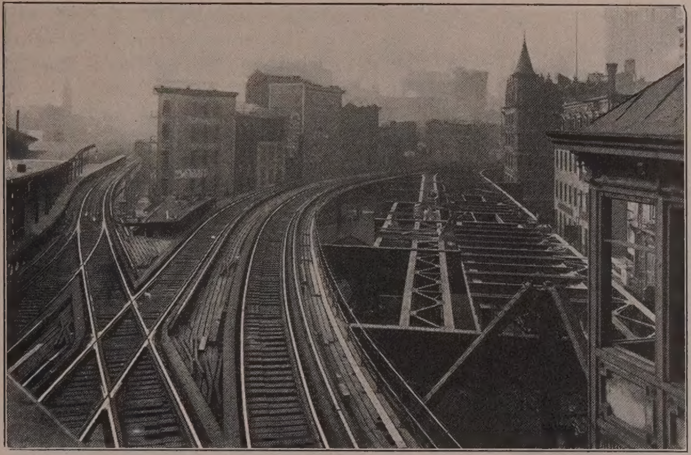
The layout of the old and new tracks is shown in the accompanying drawing. The two west, or lower-deck, tracks on Park Row will be used for Third Avenue trains, while the two east, or upper-deck, tracks will connect with the Second Avenue line. The problem of where to start work so as to secure uniform progress and keep a large enough force to insure rapid completion effectively employed at all times was a complicated one. It received considerable attention from the engineers of the Interborough Rapid Transit Company, and the main features of the erection scheme first outlined were carried out with little change and with great success by the contractors.

First, the old signal tower on the west side of Chatham Square, which interfered with the new southbound Park Row tracks, was taken down and replaced by a new structure at the corner of Division Street and the Bowery. Next, a stiffleg derrick set the first panel of steel at the north end west of Chatham Square and erected on it a traveler, facing south. This traveler then erected the new southbound Third Avenue track, the girders under the new west platform and part of the new west center track down to the lower end of the platform. From this point the new cross-girders, columns and stringers required to join on to the existing tracks were put up with a ginpole by a hoist on the street. The southbound Third Avenue track was then connected and operated, while a "jinny-wink" set east of the new platform took out the old southbound track and finished setting steel for the new track east of the new west platform. This track was then put in service for northbound traffic, leaving the old sweep across the center of the Square entirely clear for reconstruction. The derrick was set up again where it could replace the north panels of this sweep. As soon as this was done a large traveler was erected which put in the two east tracks and followed them down to the end of the double deck at Brooklyn Bridge. The "jinny-wink," moved over from the new northbound track, backed away from this traveler, removing the old steel, to the

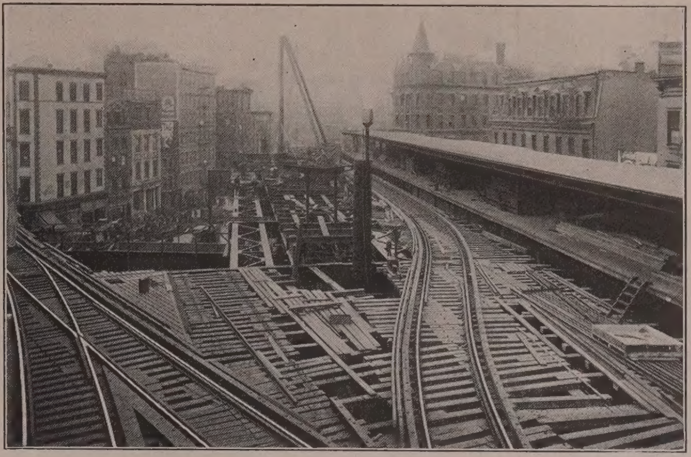




COMPLICATED SECTION WAS REBUILT IN A YEAR WITHOUT SERIOUS ACCIDENT AND WITH NO DELAY TO TRAFFIC



FIRST STEP, PARK ROW LINE FROM CHATHAM SQUARE



INTERMEDIATE STEP, PARK ROW BELOW CHATHAM SQUARE

point on Park Row near Pearl Street where the old structure ran into the two tracks in operation. Here the "jinny-wink" was taken down.

Meanwhile, starting at Pearl Street and working south, a crew armed with ginpoles and hoisting engines were shoring the existing track stringers, reinforcing or replacing the old cross girders, and erecting double-deck columns in place of the old ones.

Work on New Bowery

The largest traveler used on the section was started at the south end of the "hump" on the New Bowery line. It moved north, replacing the old cross girders and erecting the double-track "hump" on them across Chatham Square and up the Bowery to the end of the section near Pell Street.

Much temporary work was also required while new bridges, stairs and platforms were being built for handling passengers, both at Chatham Square and at Brooklyn Bridge.

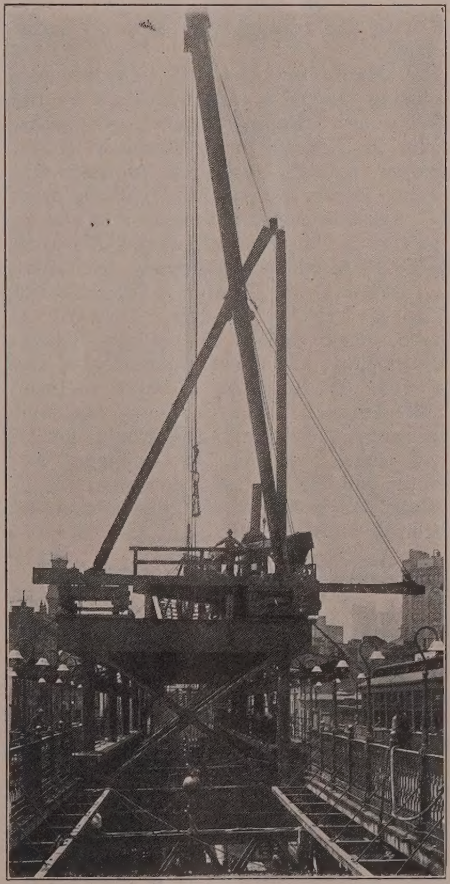
Erection Proceeds Backward

In putting up a new structure, the columns are generally erected first, then the cross girders and finally the stringers. In the erection on Park Row this order was exactly reversed. The stringers, which, for the lower deck, were the old ones, were already in place. They were blocked up on girders spanning the street on both sides of each bent, which were carried on timber towers. At one time during the erection there was actually a greater weight of steel in this falsework than in what was left in place of the elevated structure itself. The old cross girders and columns were taken out while the tracks were supported in this way without in the least disturbing traffic.

The new cross girders were put up in advance of the new columns, as the brackets on the latter would not have let the girders go up if the columns had been placed first. To get these girders past the ends of the adjoining stringers the top flanges of some of them had to be taken off. The girder would be raised to clear street traffic by a ginpole at each end, and blocked up from the towers supporting the track. The top flange would then be lifted off complete, and tilted so that it could be wriggled or rolled up between the ends of the stringers and put where it belonged. The rest of the girder was then raised after it, assembled and blocked in place, and connected to the stringers. The columns were then set, the two-story ones being handled all in one piece.

"Chicago Derricks" Work Well

Where the top flange could not be placed by this method, it was slid in from the end after the rest of the girder was erected. For this service a "Chicago derrick," made by stepping one of the ginpoles against the last column set, and guying it back to the column so that it could be used as a boom, proved useful. When clearances would not allow this method, the top flange would be taken entirely apart, the angles worked up through the ends of the stringers, the rest of the girder set, and the wide, thin cover plates rolled in from one end. This was done by curling the plate, entering one end, holding up the middle of the plate near the entering point with the "Chicago derrick," and holding down the tail of the plate with a set of falls to make it clear adjoining buildings. The plate would then be dragged around this curved path with another set of falls, feeding into place like a stiff ribbon.



TRAVELER ON NEW BOWERY

A number of these cross girders were received "knocked down," and each piece, consisting of cover plates, flange angles and web in three sections, was erected separately, the girders being assembled and riveted in place. This method was necessitated by the narrowness of the street and the arrangement at some points of the shoring required to support the track stringers.

The largest girder set, at Duane Street and Park Row, weighed 30 tons, and required 18 min. to drag it into place, raise it clear of traffic and block it up on the timber towers.

Tall Ginpoles Used

The gin poles used on this work had to be leaned toward their load and handled on a main guy and two side guys, as the narrow street gave no room to spread out guys in the usual fashion. This rigging was carefully done, and handled very successfully. In one instance a 56-ft. ginpole was required. Many of the tallest columns, however, some weighing 8 tons, were set with 35 or 40-ft. ginpoles, made of single-length 12 x 12-in. timbers. Where it was not possible to set a pole at each end of a girder to raise it, two sets of falls on each side, making a pair at each end of the girder, were used. Each pair was joined by a short sling passing under the girder, and the upper block of each set of falls was hitched to a beam resting on the elevated structure itself.

Pearl Street Girders Erected in Three Parts

Two of the new girders under the Chatham Square station were slid into place from one end on blocking. The old elevated on Pearl Street and the New Bowery, like that on the Bowery, consisted of two independent tracks, each carried on top of a row of columns at the side of the street and connected at intervals by cross bracing. These columns were reinforced at the top and connected by cross girders which carried the double-track "hump." The middle sections of most of these girders on Pearl Street, which rested on top of the old columns, were spliced in the field to the end sections. The ends were raised over the street and slid on top of the columns between the old stringers. The

"HUMP" ON NEW BOWERY STARTED, RECONSTRUCTION ON PARK ROW WELL ALONG

middle sections could then be raised and connected to the two ends.

On the New Bowery, where the old track grade is well above the street, the new girders framed into the sides of the existing columns, instead of resting on top of them. Here brackets were first riveted to the posts. The girders were then landed on these brackets, and the end-connection angles and bottom flanges drilled to match in place. On account of the irregularities of the old structure, which has been in service thirty-seven years, this work could not possibly have been done in the shop. Much of the old steel had to be plumbed and realigned. Nearly every pair of old track stringers on Pearl Street had to be cut off or lengthened, and many of them dragged endwise for short distances to match up with the new steel. This feature of the work had been carefully measured and detailed, and worked out very accurately.

EQUIPMENT USED

Two of the main travelers and the derrick were equipped with electric hoists, while the third traveler, which built the New Bowery "hump," had a steam hoist. Three electric hoists and several steam hoists were used on the street to operate the ginpoles and "jinny-wink." These were moved by running the hoisting line out ahead and dragging them along on their skids. Compressed air was supplied all over the section through 3-in. lines by a 310-ft. compressor. This was located, with a boiler, on the street under the Chatham Square station. Wire-rope slings were used in preference to chains in all rigging, and the contractors are well satisfied with the results from a safety point of view.

The Manhattan elevated improvements are being designed and supervised by the Interborough Rapid Transit Company, George H. Pegram, chief engineer, F. W. Gardiner, principal assistant engineer and S. Johannesson, general assistant engineer. H. C. Soest is assistant engineer in charge of section 1. The contractors for this work are the T. A. Gillespie Company, executive, the Terry & Tench Company, Inc., and the Snare & Triest Company. Edward J. Govern, vice-president of the T. A. Gillespie, Company, has general direction of the work. H. D. Robinson is chief engineer for the Terry & Tench Company, Inc., and several sections, including section 1, are in direct charge of W. R. Coppage, superintendent for the same company. J. T. Watkins has had charge of the erection of section 1.

Draw Diagrams for Beams Reinforced for Compression

W. W. Clifford and C. H. Mangold Give Graphical Solution for Formulas of Joint Committee Which Are Useful in Investigations

THE DISCUSSION published by W. W. Clifford and C. H. Mangold in the September *Journal* of the Boston Society of Civil Engineers of a paper on "Some Special Methods of Reinforced-Concrete Design" in the same issue by M. J. Lorente, presented Sept. 15, contains useful graphical diagrams for the investigation of beams reinforced on the compression side.

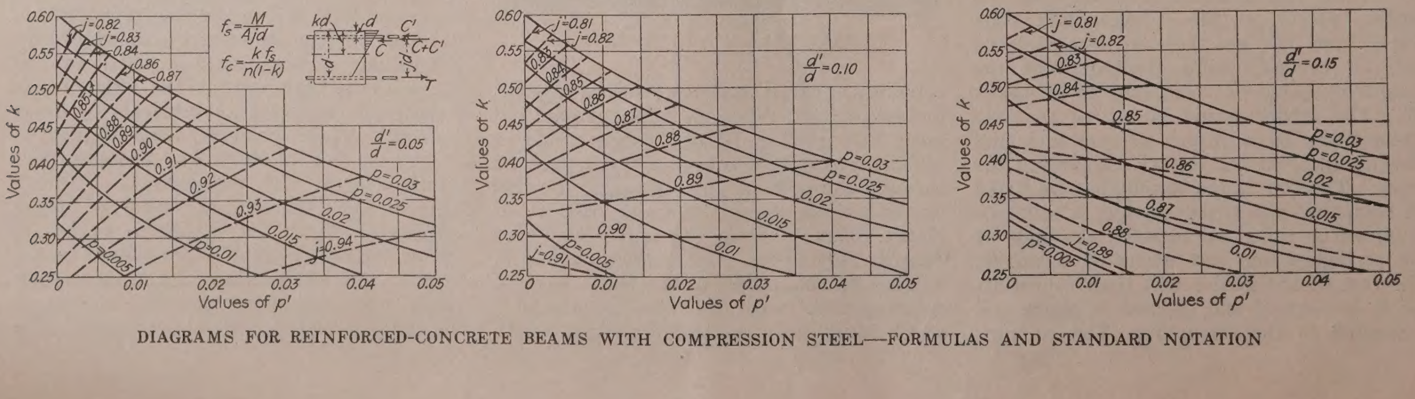
The accompanying graphical solution of the standard formulas for k and j (using standard notation) has been found to be simple and useful. These are curves giving j with p' and k as co-ordinates superimposed upon similar curves for p. The curves given are for three values of d'/d, 0.05, 0.10 and 0.15, which will cover most practical cases. The curves for the value of d'/d next larger than the actual value will give a small percentage on the side of safety, and be well within the precision of the actual work. For special cases interpolation between the curves is easily made.

As an example of the use of the diagrams, assume the investigation of a beam which has an external bending moment of 1,625,000 in.-lb., $d'/d = 0.10$, $d = 21$ in., $p = 0.025$, $p' = 0.02$, and an area of tension steel of 6.30 sq. in.; n is assumed to be 15. Entering the middle group of curves ($d'/d = 0.10$) at the top, where the value of p' is 0.02, and dropping vertically downward to the $p = 0.025$ curve, we read $k = 0.45$ and $j = 0.876$. Then

$$f_s = \frac{M}{Ajd} = \frac{1{,}625{,}000}{6.30 \times 0.876 \times 21} = 14{,}000$$

and

$$f_c = \frac{kf_s}{n(1-k)} = \frac{0.45 \times 14{,}000}{15(1-0.45)} = 763$$



DIAGRAMS FOR REINFORCED-CONCRETE BEAMS WITH COMPRESSION STEEL—FORMULAS AND STANDARD NOTATION

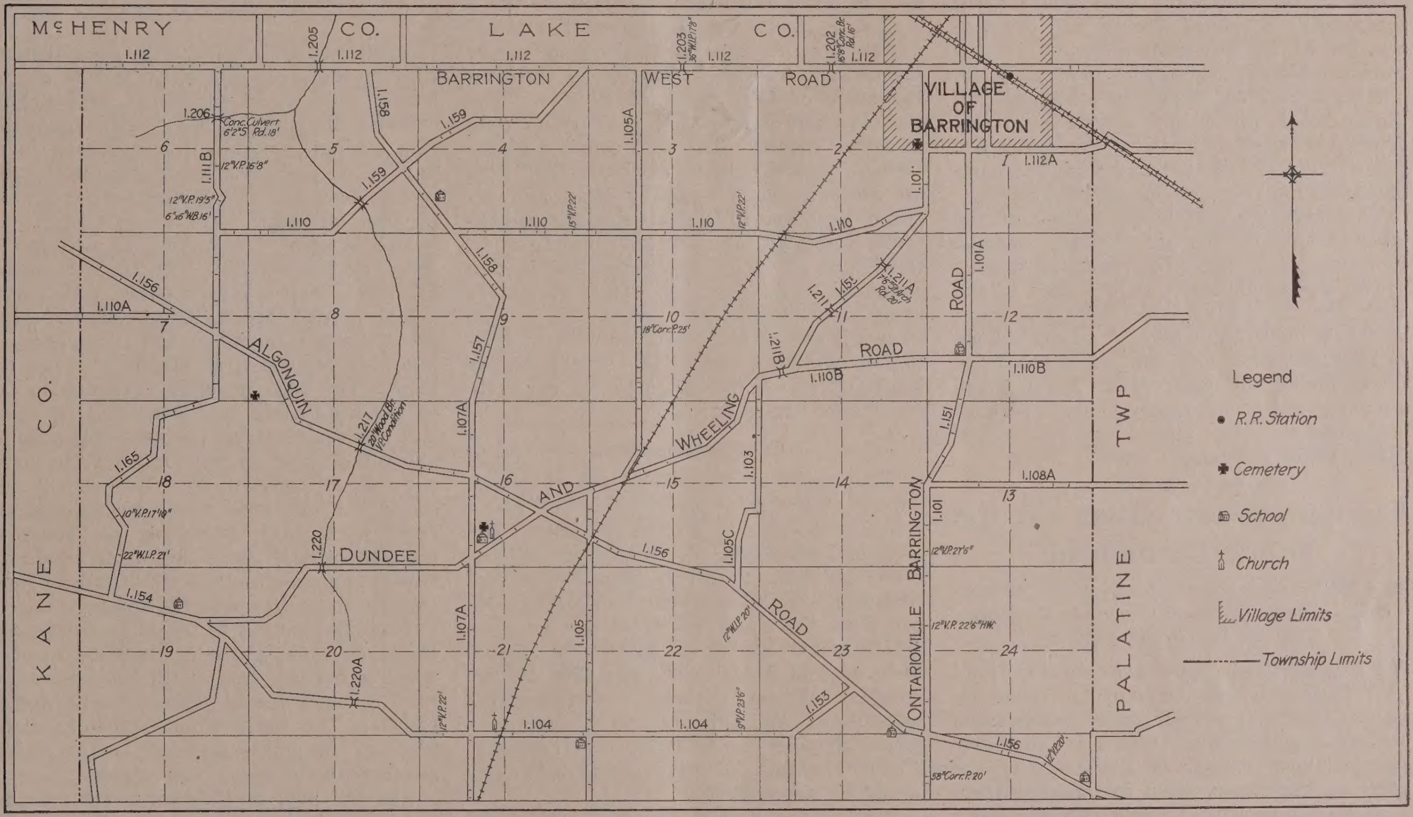
Illinois Utilities Commission Adopts Water Service Rules

ILLINOIS water service rules were recently adopted by the Public Utilities Commission. Some of them are as follows: Recording pressure gages must be maintained in towns of 300 population or more. Meter bills must show the amount of water falling between each pair of limits where a sliding scale is in effect. Consumers and fire departments must be notified six hours in advance if the service is to be interrupted. Meter-testing facilities must be provided unless specifically excused. Limiting errors for one-eight and one-half flows are 4 per cent, and for full flows, 2 per cent. The frequency of tests is as follows: ⅝-in. meters every ten years or after passing 100,000 cu. ft.; ¾-in. meters in eight years, or 150,000 cu. ft.; 1-in. meters six years, or 300,000 cu. ft.; and all large meters every four years. A free test may be granted a consumer if the meter have not been tested within a year. The fee for 1-in. sizes and smaller in service less than twelve months is $2. For sizes up to 2 in. the charge is $5. If the meter is more than 2 per cent fast the utility shall pay the consumer the amount of the fee.

Highway Superintendent of Cook County, Illinois, Simplifies Filing System

Road and Bridge Plans Are Indexed by Logarithmic Designations Which Show Their Precise Location in the County

ALL DATA relating to roads and bridges in Cook County, Ill., are filed relative to their location in the county, rather than to their name. This method was selected by George A. Quinlan, county superintendent of highways, for the reason that in discussing a bridge one usually looks on a map to find its location. Finding it on the map, by the Cook County system, locates it in the file. This is accomplished by means of a numbering scheme in which by the arrangement of numbers in a logarithmic form one can tell the township, section and number of the bridge. Thus, when a farmer from Barrington township wanders into the office to see the county superintendent about "that bridge near the Methodist Church west of the railroad," the superintendent goes to a large county map on the wall and finds that the bridge is in section 20. He then combines the township and section numbers, obtains the logarithmic file number and within a minute or two after the farmer's question has all data relative to the bridge in question at hand.



THIS SAMPLE MAP OF PART OF BARRINGTON TOWNSHIP SHOWS HOW THE NUMBERING SYSTEM IS APPLIED

Applying the Numbers

For bridges a characteristic or index number is given to each township in the county, according to its position alphabetically; thus, Barrington is labeled No. 1, Bremen No. 2 and Calumet township No. 3. The mantissas reserved for the bridges in a township are from 0.200 to 0.299. These figures are placed so that the digit before the decimal point indicates the township and those following designate the section number. Thus, a bridge in Barrington township, section one, would be labeled 1.201.

It frequently happens that a bridge is constructed on a section line. In order to prevent cross filing of a bridge in one township in two sections it was decided that a bridge or culvert on section lines would take the number of the section south or west of it. Thus, a bridge in Barrington township on the east-and-west line between sections 17 and 20 would be 1.220, although it is partly in section 17. This rule is also applied to a bridge that lies on the dividing line of a township. If there is more than one bridge in a section the letters *A*, *B*, *C* or *D* follow the section number when the bridge is on an east-and-west road, and *M*, *N*, *O* or *P* when it is on a north-and-south road.

Where culverts or bridges are let by contract, if more than one is built in the same township, although they are in various sections, the contract is filed under the general heading of bridges for the township and takes the designating number of the township, such as 1,200. A note stating that the culvert will be found under that particular general classification is filed under its proper location.

How Roads Are Designated

Correspondence relative to road contracts and plans is filed in somewhat the same manner as for bridges, that is, each township has its number. The roads are numbered according to their direction and location. The mantissas of township roads range from 0.100 to 0.199. All roads running north and south are given an odd number. Unless they are on section lines there is added the classification of *A*, *B*, *C* or *D*, relative to their position with respect to the distinguishing section-line road. For example, the first north-and-south road in Barrington township would be 1.101 and would be on the west section line of the first sections of that township. Then 1.101A would be the first road to the right of it in the same section. If a road runs along a section line for one mile, and is then closed and extends east or west, the number ceases when it turns off.

In view of the fact that there are at the most seven section lines to a township, those roads running north and south would have mantissas from 0.101 to 0.113. The roads east and west would have from 0.102 to 0.114. For roads that run diagonally, in a northeasterly or northwesterly direction, mantissas above 0.150 are used—odd for those running in a northwesterly direction and even for those running northeasterly.

Classifying the Roads on Cards

In the inspection of roads it was the intention to submit an annual report, and in this to state the condition of all highways in the county and show the materials of which the various roads were built. To get these data a map of the county, drawn to a scale of 1 in. = 1 ft., was cut up into its respective townships and pasted on cloth. These cloth-backed township maps have been bound loosely about pocket size, and every time a road is traveled there is marked on the map in ink the material of which the road is made and its approximate length as shown by an automobile speedometer. At the end of the day a road-inspection card is made out, and separate cards are made out for each classification of the road. These cards are then filed in a small index, and are located according to the number.

Complete information in regard to each bridge is filed in an envelope on bridges.

However, for handy indexing and a thorough idea as to the condition of each bridge and date of its last inspection, a bridge-inspection card is kept. This card is filed in an index system of bridges and by its number can be found readily when needed. It is also cross filed, so that when the bridge is inspected the following year only a report as to its condition and general information need be made on the inspector's card. On the back of the bridge card a small sketch of the existing structure is drawn with a few essential dimensions. Photographs of the bridge are taken from time to time and attached to the card. A postcard autographic camera is used and the notation on the film is printed out.

For construction reports on all bridges built at the expense, whole or in part, of the county, the inspector in charge fills out a daily postcard report. This report gives the number of hours worked and the percentage of the different elements of the work completed. As soon as these daily reports are received they are tabulated and pigeon-holed under the name of the job. When the work is finished the cards are taken out, tied together and filed in a compartment reserved for completed bridges.

The inspector also keeps a book of the labor record of the job for the various items, material and piling data, as well as gravel and sand tests. In the back of the book are the instructions from the engineer relative to the work. A separate book is kept for each job, and when the work is completed the daily cards are checked with the bridge cost-record book. The data contained is also placed on cost-record cards, which are posted weekly.

Bumping Posts That Do the Work Demanded

Steel Buffer Anchored to Heavy Blocks of Concrete Prevents Runaway Cars from Crashing Through Into Waiting Room

Wherever there are stub railroad tracks trains or moving cars are bound to overrun their ends occasionally. In passenger terminals this is obviously fraught with danger to the users of the station; there have been instances of persons on the concourse being run down and killed, and even of trains passing entirely across the concourse and crashing into or through the station building. On the other hand the time element in the movement of trains into such terminals is usually vital, and the trains must be got in quickly. Hence when the Hoboken terminal of the Delaware, Lackawanna & Western Railroad was built it was assumed that there would be occasional accidents and an attempt was made to provide a mass that would take a heavy shock. The success of the design has been such that similar posts were used in the trainshed of the Grand Trunk Railway at Ottawa, that of the Chicago & North Western Railway at Chicago, the new Lackawanna station at Scranton and the Jersey City terminal of the Central Railroad of New Jersey recently rebuilt. They are also being installed in the new Buffalo terminal of the Lehigh Valley Railroad. The latest proof of the effectiveness of this type of bumper occurred Aug. 17 at the Hoboken terminal, when a string of six steel coaches struck one of the posts a terrific blow and raised its outer end several inches, but stopped instantly with injury only to the post and the end coach.

Fig. 1 shows the details of the latest design for this type of post where a pile support is required—that to be installed for some of the tracks at Buffalo. The Hoboken and Jersey City posts differ only in minor details. The post consists essentially of a steel built-up block provided with an ordinary Ellis bumping head and securely anchored to two large blocks of concrete, which in turn are anchored to piles, the heads of which are embedded in and anchored to the concrete. Thus the entire mass is monolithic, and unless it is broken in two it cannot be moved far without pulling or shearing the piles. The bumping head is high enough to catch the car body instead of the coupling.

Cost of Bumper

The depths of the blocks will of course depend on the elevation of top of rail above continuous water to protect the piles. The Buffalo design calls for 19.1 cu. yd. of concrete per bumper, which should cost less than $200. In all of the designs where piles are used there are ten piles per bumper, which would cost about $100. The actual steel used at Jersey City was 7764 lb. per bumper. Under average conditions this would cost approximately 3½ cents per pound in place, or $270 for the steelwork. Hence the cost of the complete bumper would be about $600.

Part of the Buffalo terminal is on hard ground where no piles are required. Here the concrete base will be of the design shown in Fig. 2, with the two blocks of concrete combined into one long, shallower strip involving about the same amount of concrete. With the piles eliminated the cost of this type would be about $500.

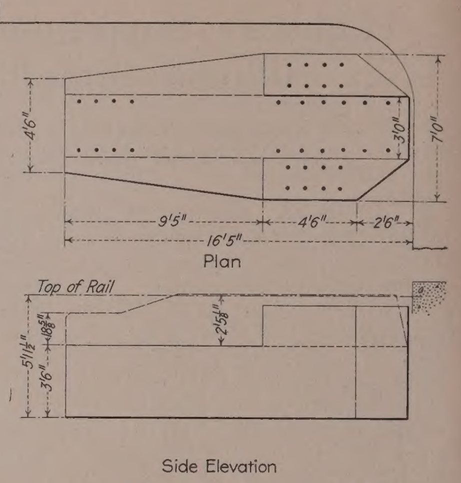


FIG. 2—SUBSTRUCTURE WITHOUT PILES

Still another variation in the substructure is found on the south tracks at Hoboken, which come outside an old bulkhead crossing the ends of the tracks diagonally. The triangle outside this bulkhead is on new fill carried on a heavy platform at the water level, and the bumpers rest directly on the platform.

The bumper struck Aug. 17 was one of those on the old fill. The train consisted of six engineless steel coaches which were being shunted into the trainshed, and while their speed is more or less conjectural, it has been estimated at nearly 12 miles per hour. The Ellis head was broken, the top of the steel block was somewhat battered, and the entire structure was driven ahead about 6 in. and slightly rotated, the outer end rising about 4 in. The end of the coach was also somewhat crushed and the rails were bent, shearing off some of the fastenings, but the train did not ride the bumper, and the picket fence bounding the concourse was not touched.

The effectiveness of the bumper was also shown last year at the Jersey City terminal when a five-car train with locomotive ran head on into one of them. There was no rotation, the mass simply pushing ahead 2½ in., the piles evidently being driven ahead with the rest of the mass.

The bumpers at Hoboken were designed and constructed under the direction of Lincoln Bush, consulting engineer, of New York City, who was at that time chief engineer of the Delaware, Lackawanna & Western Railroad. Mr. Bush also designed those for the Scranton, Jersey City and Buffalo stations, his design also being used at the other points noted.

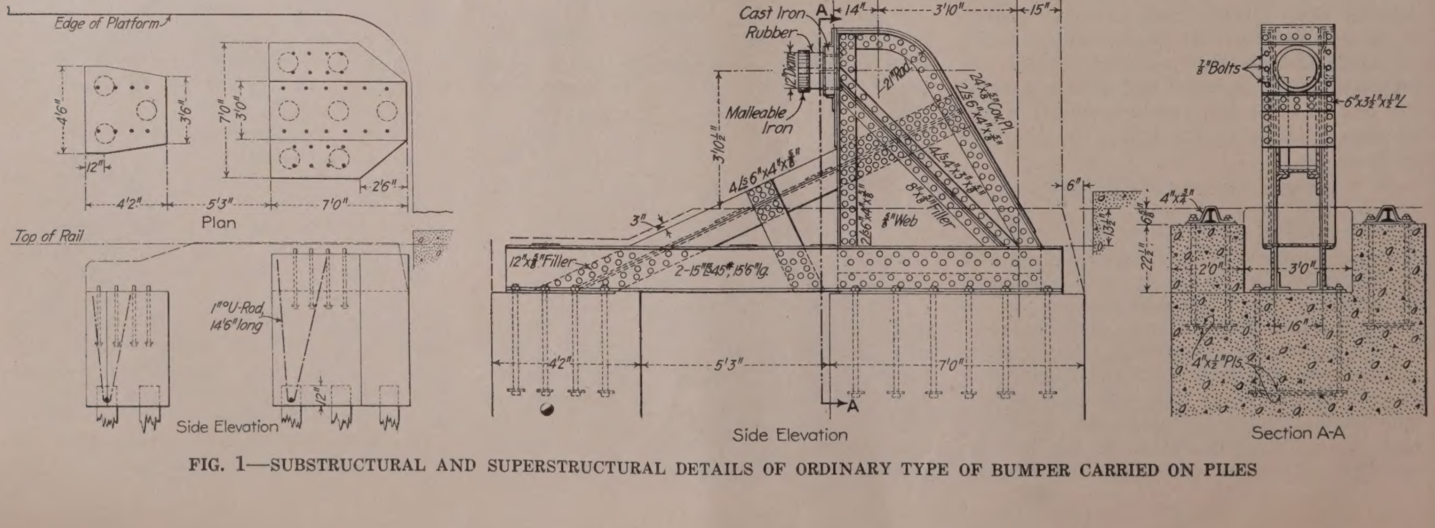


FIG. 1—SUBSTRUCTURAL AND SUPERSTRUCTURAL DETAILS OF ORDINARY TYPE OF BUMPER CARRIED ON PILES

Paving a Leading Factor in City Betterment

Abstracts of Papers by Clarence D. Pollock, Ellis R. Dutton, R. M. Cooksey, and W. C. Perkins, Presented This Week at Convention of American Society of Municipal Improvements Held in Dayton, Ohio

Napped or Recut Granite Paving in Baltimore

By R. M. COOKSEY
Principal Assistant Engineer, Baltimore Paving Commission

THE first work undertaken along this line was the re-heading and re-jointing of old blocks. This did not prove satisfactory, for in re-heading it was often necessary to cut as much as 2 in. off the depth in order to save the thickness in a case of badly rounded blocks, resulting in the block being made too shallow. This method also made the cutting expensive, as, in order to secure a well dressed head, it was necessary to use a pointing tool, making the work of the cutter slow, and, of course, the price of the cutting higher.

The old blocks which are used for this work vary in size as follows: 8 to 14 in. long, 4 to 6 in. wide and 6 to 8 in. deep, and all of the above varying sizes are often cut and used on the same piece of recut paving. The specifications for redressing the blocks are as follows:

"The contractor will assort, clean, split, reel and redress the blocks so as to have rectangular faces, free from bumps, with straight edges on the tops, ends and sides, so as to form, when laid close, joints not exceeding ¾ in. in width. The blocks are not to be over 6 in. in depth."

As we nap practically all of the blocks, with the exception of a few which are used as starters in order to break the joints, the average block laid on recut work in this city is about 6 in. long, some of them running as short as 4 in. and all will average about forty-two to the square yard. In using the napped block throughout, we find that we obtain a surface equally as good as we have ever gotten by using a new granite block, and at a cost of about two-thirds of that of new granite.

There still exist in this city about 700,000 sq. yd. of old granite pavement on sand foundation, so that this city will no doubt continue to replace this pavement with a more suitable material, and recut the blocks so secured, placing them in heavier traffic sections.

Quite a large yardage of this pavement has been laid, using a bituminous filler, and, though it gives a very good pavement, it does not compare favorably with cement filled work. As the blocks are of such various depths, ranging from 4 to 6 in., we find it difficult to maintain a good surface where the bituminous filler is used. In future work of this class we propose to use a cement mortar bed in place of the sand cushion, and the writer believes that this will be a decided improvement, for the cement filled as well, as for the bituminous filled work.

In connection with the recutting of the old block, there are, of course, a great many blocks taken from the streets which are too small to recut. These blocks are culled and are used on a concrete foundation with cement filler for alley paving in the heavy traffic districts. This takes care of a great deal of the waste from the old original paving, and it furnishes a cheap, heavy construction for alleys and narrow streets. Where a street is being paved, carrying with it a railway area, in order to take care of the shallow blocks which are cut, the concrete base is raised within this area and the shallow blocks are culled out by the pavers when they are paving the city area. These are immediately placed in the railway area, and in this manner a uniform cushion is obtained under the blocks.

Joint Fillers for Granite Block

By CLARENCE D. POLLOCK
Consulting Engineer, New York City

THE requisites of a good filler are, that it should hold the blocks firmly in position, remain permanently in place, afford support to the edges of the blocks and thus prevent chipping and consequent rounding of the tops of the blocks. It should be easy to apply, reasonable in price, and a material which will permit of traffic directly after it has been placed in the joints of the pavement.

Portland cement grout complies with all these requirements except the last. This is a very considerable defect on important streets in the larger cities, and in general prevents its use in such places. But wherever the conditions are such that the work can be blocked off for the proper setting of the cement, both in the first construction of the pavement and whenever trenches are repaved, a Portland cement grout, conscientiously made and applied as specified in the standard specifications of this society, will give most satisfactory results. It is necessary to pay very close attention to the details in order to insure uniformly good results. In general, a machine-mixed grout is much better than one mixed by hand. If the work is carried on under a hot summer sun, the surface should be kept moist by sprinkling for at least 3 or 4 days after the grout has been poured. Sand or earth spread over the pavement and sprinkled with a hose every evening is a good method of "curing" the joints. Grout joints cannot be made satisfactorily in cold or freezing weather.

Bituminous fillers overcome the faults of a cement filler, but they have faults of their own. One that is suitable in the summer season is usually too brittle in the winter, and it breaks out under traffic. The bituminous fillers given in the society's granite specifications are used in combination with fine gravel. This has not proved a very efficient method of filling the joints. In using fine gravel, the bituminous filler tends to mat on top of the gravel, and does not go down into the small voids in the gravel. Traffic picks out the filler from the top of the joint, and then the joint is little better than the old style sand one. Much better results have been obtained by using coal tar pitch, asphalt, or a mixture of the two, in combination with sand, the sand not to exceed 50 per cent of the total.

The writer has obtained better results with asphalt fillers, and mixtures of asphalt and coal tar fillers than with tar alone. It seems to be practically impossible to obtain a straight gas-tar filler which will not crack and be brittle in cold winter weather if it is not too soft in hot summer weather. The old mixture of 100 parts of coal-tar pitch and 20 parts of asphalt, which was used as long as 20 years ago in Brooklyn, has given much better results in work which has come under the observation of the writer than the straight coal-tar pitch. Good results have been obtained with straight asphalt fillers also.

It is desirable that experiments be tried using various mixtures of asphalt and coal-tar pitch, and also using straight asphalts in combination with as much sand as the bitumen will carry satisfactorily. The finer and more uniform the sand the better the results seem to be. A sand which will pass a 10-mesh screen should be used.

There is demand for a bituminous filler that will flow into the joints readily, and stay there permanently. It should have sufficient body when cold to give a fair amount of support to the edges of the granite blocks, and protect them from the abrasion of heavy metal tire traffic. The mixture with hot sand before pouring has been a great help in improving the bituminous filler. The next step should be a determination of the proper bitumen or mixture of bitumens.

Experiences with Creosoted Wood Block Paving

By ELLIS R. DUTTON
Assistant Engineer, Minneapolis, Minn.

FROM all the observations of the use of different woods it would appear that the yellow pine used in 1902 was the best for the purpose under rather heavy traffic, but the tamarac used later shows up very well on lighter traffic streets. As you are aware, Minneapolis is a great lumber center, and in 1903 the lumber interests thought it was a reflection on them that the city should import longleaf pine from the South to use for paving, and prevailed on the City Council to use the northern Norway pine. I did not think this advisable at the time, and time and experience shows that it was not. The hardness or density of the block varied so much that the wear was uneven.

On Central Avenue, which was paved in 1905, and where the traffic is the heaviest in the city, the blocks have worn down about 2 in.

The total average wear up to the present time on the 1902 longleaf pine has been about ⅛ in. and on Norway laid in 1903 about ⅜ in. under practically the same condition.

In the Government experimental block laid in Minneapolis in 1906, the results are similar to those mentioned above, although there were many more varieties of wood used. A wood in which the fiber is not stiff enough to withstand the traffic and pounding, begins to broom up and lay over in the direction of the traffic. It will soon wear away and cause depressions in the pavement.

From all the data at hand and observations and reports from other places, it seems unwise to creosote and use for paving purposes any wood except that which has proved to be the most durable and which can be procured at a reasonable price. It does not pay to use a wood because it is cheap, as the cost of repair and renewal soon overcomes the cheapness, and in the end makes it the most expensive.

These remarks have all been on the defects in cresoted wood blocks and may leave a wrong impression in some persons' minds as to the most excellent quality of such pavements. I would say that there are in the city of Minneapolis to-day about 1,500,000 sq. yd. of cresoted wood blocks, and that the yardage of the defective pavements mentioned is only 27,730 sq. yd., or 1.85 per cent of the total. The cost of maintenance and repairs of creosoted wood blocks for the year 1914 was only 0.09 cents per square yard on the total yardage. Even the low cost was not all entirely due to the failure of the blocks themselves, but was caused by other defects, so that this cost could be reasonably reduced 50 per cent and still be charging cresoted wood blocks with all that they should stand.

Vitrified Brick Construction—Streets and Roads

By W. C. PERKINS
Chief Engineer, Dunn Wire-Cut Lug Brick Company

MANY failures occur in brick pavements which can be traced to the non-uniformity of the sand cushion or to a cushion not properly compacted. Many engineers take the ground that the only function of the sand cushion is to provide a uniform bearing for the brick wearing surface—the smooth compacted sand taking care of any inequalities of brick or any variation of the foundation. We believe that the thickness of the bed of sand should be as small as possible, never over one inch.

RESILIENCY OF CONFINED SAND UNDER TRAFFIC

It is claimed that a grouted brick pavement should have a cushion so as to give it "resiliency" under traffic. We question if sand confined between a concrete foundation and a brick wearing surface has any real elasticity. We grant it may yield, shift or be compacted by traffic weight on the wearing surface of the pavement and that the cement grouted wearing surface will of itself spring back; but the sand will not follow, and we have a small air space between the sand and the grouted brick wearing surface. This can be easily demonstrated by a hammer survey of any cement grouted brick street laid on a sand cushion. The hollow spaces are readily located. These areas may be separated by solid areas where as yet the cushion has not left the pavement. The bond at these hollow spots may be intact and show no distress, but these areas become weak spots in an otherwise good pavement and eventually there may be a settling or a breaking of the cement bond.

It has also been claimed that a sand cushion prevents the crushing of the brick wearing surface under the weight of traffic. Mere weight does not crush a grouted brick pavement laid on a solid foundation, provided it has a firm bearing or bed for the brick. If paving brick manufacturers cannot make a paving brick that will bear the crushing force of street and highway traffic, they had better stop making brick.

GOOD RESULTS HARD TO OBTAIN

Again, in actual construction, while we may give elaborate directions as to how the sand cushion is to be rolled and struck with a template, we find that to obtain good results in the field is almost impossible, and we have an unstable layer of sand varying in compactness and thickness between a solid foundation and a solid wearing surface. There is also the hazard of the sand working up between the joints of the brick and thus weakening the bond when the pavement is grouted. A rolled wet sand cushion, if it dries out after the bricks have been laid, will undoubtedly shrink and then leave hollow spots under the wearing surface.

TRY SAND AND CEMENT CUSHION

In view of all the hazards of using sand for the bedding course, engineers are beginning to turn to the use of a mixture of cement and sand. Mr. Compton, chairman and consulting engineer of the Baltimore Paving Commission, last year made laboratory tests of a cushion mixed 1 to 3, 1 to 5, 1 to 8 and 1 to 10, cement and sand, and adopted for all brick paving work this year in Baltimore a cement sand bed mixed 1 cement to 5 sand. The sand and cement are thoroughly mixed dry and then handled the same as an ordinary sand cushion. The bricks are then laid, rolled and inspected, and the pavement wet down for grouting. This adds moisture to the cement-sand bed and eventually the cement-sand bed becomes hard and practically joints the brick wearing surface to the foundation. The rolling of the brick wearing surface is kept up even with the paver. This is an advantage, for if with a cement-sand bed the paving is rolled and not grouted and we have rain, no harm is done, in fact the rain will set up the cement-sand bed. On the other hand, there is always a hazard when it rains on brick laid on sand cushion and not grouted, as the sand is apt to come up in the joints from the wash, necessitating the relaying of sections of the paving. In Baltimore, Lexington Street, the area from Calvert Street to Liberty Street, was paved with brick in 1906, on a 4-in. concrete base, using a ½-in. mortar cushion, mixed 1 to 3. Mr. Compton states that this street stood up splendidly and that no complaint has ever been made as to noise. During the last three years the street has been all "shot" to pieces by sewers, gas, water, steam heating lines, etc., so that at present it is in bad shape from "cuts," but there were absolutely no failures caused by the original construction.

Another example of the durability of a grouted brick pavement laid on a cement-sand bed is furnished by the paved approaches to the Pennsylvania Railroad Terminal in New York City. These approaches were paved in 1910, the bricks being laid on a cement-sand bed mixed 1 to 3. The pavement to-day shows no signs of deterioration except along the curbs where the wheels of heavy loaded wagons skidding down the inclines have cut into the bricks.

THEORETICAL TYPE

The theoretical type of construction is that developed by W. T. Blackburn of Paris, Ill., who, assisted by Mr. Parrish, a local contractor, is laying the brick wearing surface direct on the freshly laid concrete foundation. An article by Mr. Blackburn on this subject was published in the Engineering Record of July 10, page 54.

The advantages claimed in using the cement-sand bed or the new type of construction as developed by Mr. Blackburn are: Elimination of the hazard of the sand cushion, as the pavement will not be injured at any time by rain, the wearing surface, with the exception of the filler, being completed each day. If a rainstorm intervenes no damage is done, as there is no sand cushion to become saturated and cause worry about rolling the brick surface. Each brick in the wearing surface will be assured a cement bond its entire depth, for if the cement sand should work up in the joints, it will set up and prevent the shearing action which tends to crush the top of the brick. There is no chance for the bed to shrink or shift away from the bottom of the brick wearing surface, as the brick is firmly bedded in the cement sand or held in the mortar of the concrete base. Where these pavements have been laid there seems to be a total absence of any rumble under traffic. Slight settlements and breaking of bond due to non-uniformity of sand cushion are eliminated.

Test Concrete Poured 700 Feet Through Vertical Pipe

Standard Cylinders Generally Show Greater Strength for Poured Concrete at Moodna Siphon than for Mixer Concrete

COMPRESSIVE TESTS of standard 8 x 16-in. cylinders have been made for the New York Board of Water Supply for the purpose of determining the effect on the quality of concrete when dropped through a vertical pipe 700 ft. long at the supplementary shaft and tunnel of the Moodna Siphon, described in the Engineering Record of April 24, 1915, page 514. The results, reported in the monthly bulletin of tests made in New York City laboratories for July, are given in the accompanying table.

While the tests are few and are not conclusive, the concrete was evidently not injured by this unusual treatment. All of the specimens at the earlier ages are stronger for the poured concrete than for the concrete from the mixer. At the age of 32 days one result for the mixer concrete is seen to be much higher than the two tests of concrete from the forms. The materials were Alpha cement, granite screenings and crusher-run granite in the proportion of 1:2:4.

COMPRESSIVE TESTS OF STANDARD 1:2:4 CONCRETE CYLINDERS—NEW YORK BOARD OF WATER SUPPLY

Description	Strength, lb. per sq. in.			
	21 days	22	30	32
From form in tunnel..	3,255	2,945	3,070	2,890
				2,495
From mixer at top....	3,095	2,855	1,940	3,220
	3,000	2,835	2,085	

BRITISH COLUMBIA LUMBER COMPANIES have formed an association at Vancouver, B. C., for the purpose of exporting lumber direct from the mills to markets throughout the world. The combined production of the mills represented is said to be approximately 1,000,000 ft. b.m. per day. Quotations will be made to include a guaranteed freight rate so that buyers will know the exact delivery price. The association announces that it will maintain a certain quality standard and adopt a brand under which its products will be sold.

Economy of Deep Sewage Filters Explained on Basis of "Held" Water and Hydraulics

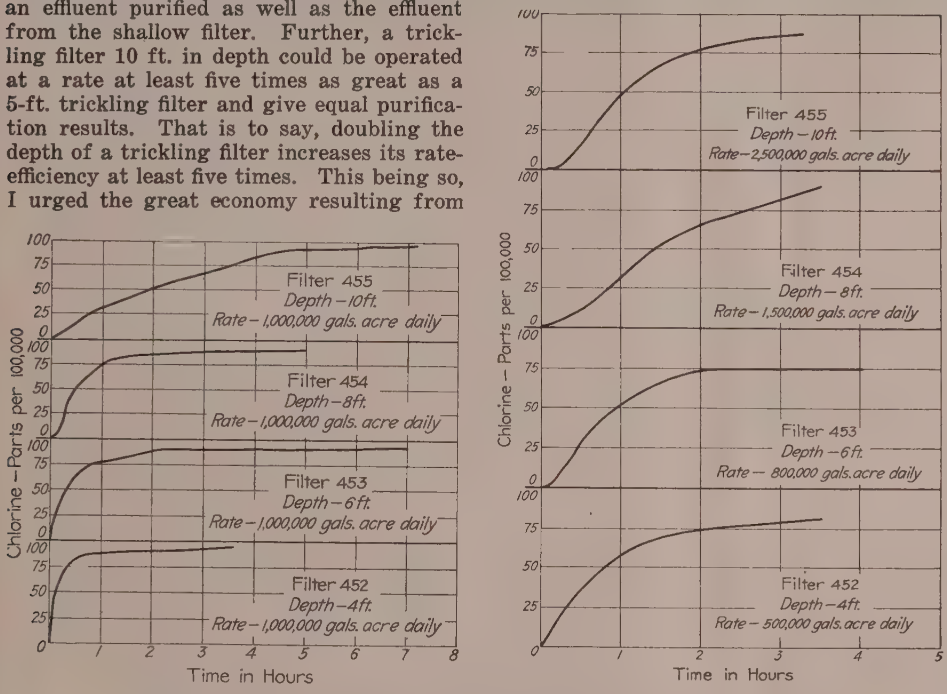
Paper by H. W. Clark, Chemist in Charge of Lawrence (Mass.) Experiment Station, Presented at Convention of American Public Health Association at Rochester, N. Y.

IN an article entitled "The Depth of Filtering Material and Trickling Filter Efficiency," read before the Boston Society of Civil Engineers last winter, I presented the rate-efficiency results of a number of trickling filters which have been in operation at the Lawrence Experiment Station for periods of from two to sixteen years. In that paper I showed that, judging from the Lawrence data, a trickling filter 10 ft. in depth could receive sewage at a rate at least six or seven times as great as a trickling filter 4 ft. in depth and still produce an effluent purified as well as the effluent from the shallow filter. Further, a trickling filter 10 ft. in depth could be operated at a rate at least five times as great as a 5-ft. trickling filter and give equal purification results. That is to say, doubling the depth of a trickling filter increases its rate-efficiency at least five times. This being so, I urged the great economy resulting from the construction of deep instead of shallow filters of this class.

The accompanying table illustrates the rate and results of the operation at Lawrence of four trickling filters, 4, 6, 8 and 10 ft. deep, respectively.

HYDRAULICS OF FILTER FLOW

After looking at these results the question, of course, arises as to the cause of the great rate-efficiency of the deeper filters. Why should a filter 10 ft. deep allow not simply a rate two and one-half times as great as a 4-ft. filter with equal purification but a rate five or six times as great? The explanation, when worked out, is comparatively simple and shows these striking results to be due simply to the hydraulics of the flow of the sewage through the filtering material. Twenty-five years ago in the first special report of the Lawrence Experiment Station, the flow of water through sand filters was described (Special Report for 1890, "Purification of Sewage and Water," by Hiram F. Mills, C.E., page 18). This description, based upon experiments then made, showed that when water or sewage is applied to a sand filter which, at the time of application, contains much water in its interstitial spaces, some of the applied water will, especially in filters of coarse sand, pass by the held interstitial water instead of pushing it before it and appear at the filter outlet ahead of a large percentage of the held water. This held water is really partly interstitial water and partly absorbed water; that is, water held or absorbed by the organic matter lodged in the filters.



TIME OF PASSAGE THROUGH FILTERS UNDER DIFFERENT CONDITIONS

Now the rate and purification results in the operation of trickling filters of different depths have to do with this flow of water and the *progressive mixture* of the applied with the held water in filters of broken stone or other coarse material and with filtering depths varying in the cases cited in this paper from 4 to 10 ft. In the early work only sand filters 5 ft. in depth were studied.

In this recent work I have revealed a factor not noticed in the sand filter studies of twenty-five years ago, which affects the results very materially. This is the simple fact, made clear by the recent work, that the deeper the trickling filter up to a certain point the greater the tendency of the applied water to mix or mingle with the held water instead of passing by this held water. This tendency to mingle as the filter depth increases and to push the held water toward the underdrains is great enough to cause a large percentage of sewage passing through a 10-ft. filter to be not simply twice as long in passing as through a 5-ft. filter but five or six times as long. Conversely, the rate of the deep filter may, on account of this condition, be from five to six times that of the shallow filter with equal purification results. This is illustrated by the accompanying diagrams.

EXPERIMENTS AT LAWRENCE

We have on these diagrams data from experiments made by me at Lawrence in regard to the flow through the four trickling filters; the rate and purification results are shown in the table for filters 452, 453, 454 and 455, which are 4, 6, 8 and 10 ft. deep, respectively. On the first diagram, we have the results shown when each filter was being operated at the rate of 1,000,000 gal. per acre daily. In order to determine the time of passage of the water or sewage through the filters operated at this rate and the degree of mingling of applied and held sewage, enough salt was placed at a definite time in the applied sewage to raise the chlorine 100 parts in 100,000, this amount, of course, being readily detected in the filter effluent. Increased chlorine in the effluent, due to the large application, was detected with equal readiness.

After the application of this salt sewage to each filter, samples of the effluent were collected every few minutes for the determination of chlorine. An examination of the diagrams will show that 50 per cent of the salt sewage applied to filter 452 appeared at its outlet in about 12 min. mingled with 50 per cent of the held sewage; that is, the chlorine had increased to 50 parts or more in 100,000 parts. With the 10-ft. filter operating at the same rate, 1¾ hr. elapsed before an effluent containing 50 per cent of the salt sewage reached the underdrains; that is, instead of being two and one-half times as long or 30 minutes, most of this salt sewage was nine times as long in passing the deep as in passing the shallow filter. The results are given with four filters and, for clearness, the flow may be summarized as follows:

RESULTS SUMMARIZED

With a 4-ft. filter, as stated, 50 per cent of the salt sewage appeared at the outlet in 12 min., 75 per cent in 18 min. and the remainder came slowly mingled with the "held" sewage through many hours. With filter 453, 6 ft. in depth, 50 per cent appeared in 18 min., 75 per cent in 42 min. and the remainder appeared as with the first filter mingled with the held sewage through many hours. With filter 454, 8 ft. in depth, the elapsed times were 48 min. and 1½ hr., respectively, while with the 10-ft. filter, as stated, the elapsed times were 1¾ hr. and 3½ hr., respectively.

In other words, with equal rates of operation 50 per cent of the sewage applied to the 4-ft. filter reaches the filter outlet mingled with 50 per cent of the held sewage 12 min. after its application, while with the 10-ft. filter 125 min. elapse before 50 per cent of the applied salt sewage reached the filter outlet mingled with 50 per cent of the held sewage.

It follows, then, that at this rate, 1,000,000 gal. per acre daily, 50 per cent of the sewage is subjected at the most to only

AVERAGE ANALYSES OF FILTER EFFLUENTS. MARCH-JUNE, 1915

(Parts in 100,000)

Filter No.	Depth of filter (feet)	Rate, gallons per acre daily	Ammonia, albuminoid			Chlorine	Nitrogen as		Oxygen consumed	Per cent of samples stable
			Free	Total	In solution		Nitrates	Nitrites		
452	4	490,375	1.6375	.3413	.2180	12.55	1.15	.0045	2.30	80
453	6	784,625	1.8688	.2663	.1880	12.55	1.19	.0313	1.90	100
454	8	1,471,250	1.6687	.3862	.2200	12.10	1.45	.0067	2.25	100
455	10	3,200,000	1.7625	.2625	.2040	11.85	1.49	.0017	1.90	100

12 min. bacterial action in the 4-ft. filter, while in the filter 10 ft. deep, 50 per cent receives, at the most, 125 min. bacterial action.

Now to reverse the application of the data gained in this way, these four filters were operated at rates of 500,000, 800,000, 1,500,000 and 2,500,000 gal. per acre daily at the time of a second experiment. Applying salt sewage as before and collecting and determining the chlorine in samples from the outlets made clear, as will be seen by an examination of the diagrams, that with these rates the applied and held sewage were about equally intermingled, and hence were about equal periods of time in passing through each filter. Through the shallow filter operating at a rate of 500,000 gal. per acre daily, 50 per cent of the salt sewage appeared in 50 min.; through the 6-ft. filter, operating at a rate of 800,000 gal. per acre daily, 50 per cent appeared in 55 min.; through the 8-ft. filter, operating at a rate of 1,500,000 gal. per acre daily, a little divergence was noted owing perhaps to slight clogging in this filter, as 50 per cent of the applied salt sewage was 77 min. in reaching the filter outlet, but through the 10-ft. filter, operating at a rate of 2,500,000 gal. per acre daily, 50 per cent of the salt sewage reached the filter outlet in 1 hr.; that is, filter 455, two and one-half times as deep as filter 452 and operated at a rate five times as great, gives equal time for sewage purification to occur as given by the shallow filter operating at one-fifth the rate, and hence equal purification. It is evident, moreover, from the diagrams that the rate of the deep filter could have been at least 3,000,000 gal. per acre daily.

These results show very clearly the reasons for the great economy of deep compared with shallow trickling filters. These filters are constructed of stone between ¾ and 1½ in. in diameter. Filters of larger or smaller stone allow differing times of passage and degree of intermingling, hence different but comparative results.

ONE TWO-HUNDREDTH OF AN INCH is the limit of inaccuracy allowed in the 72-in. lens now being ground for the Government observatory at Victoria, B. C.

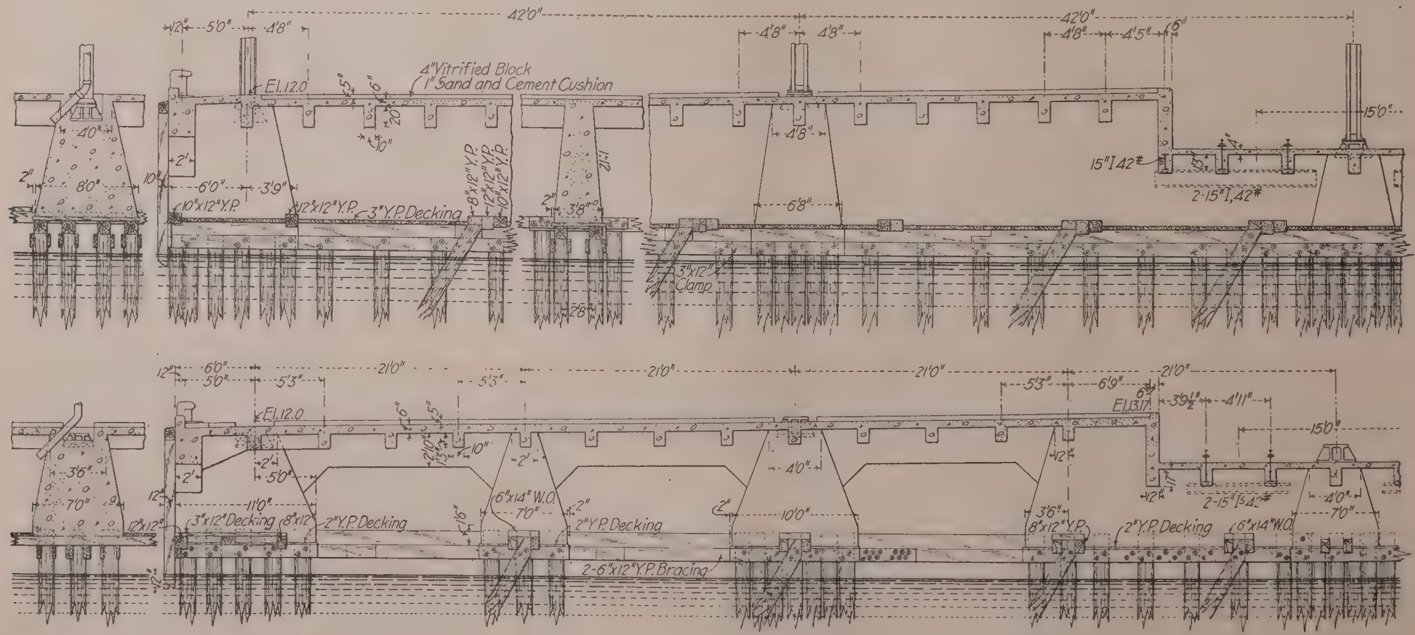
SHORE ENDS OF PIERS, JUNE 25—PIER 40 IN FOREGROUND, PIER 38 BEYOND

Philadelphia's Southwark Piers Completed

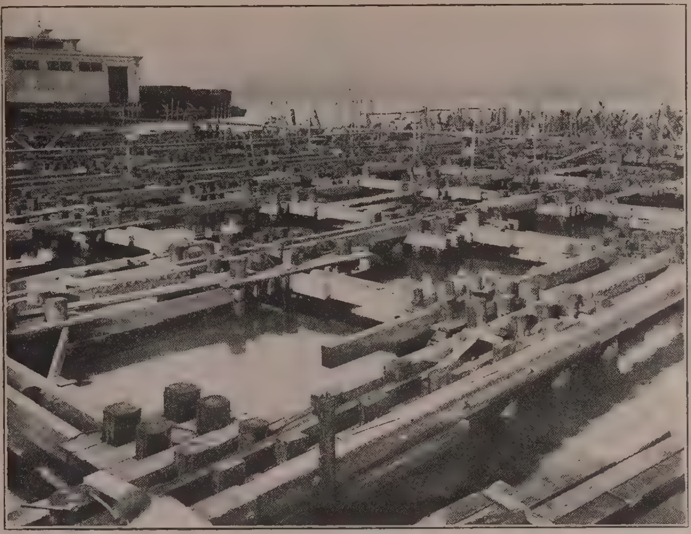
Twin Structures Are 180 Feet Wide and Unusually Light—Represent Two Types of Pile-Supported Reinforced-Concrete Substructures

TWO PIERS, known as the Southwark piers, have recently been completed in Philadelphia, and are scheduled to be formally accepted to-day. While there has this summer been begun a much larger pier—the first of a group, known as the Moyamensing group, which will ultimately give the city a continuous municipally owned waterfront development of more than a mile (see the article on the South Philadelphia improvement, in the Engineering Record of Sept. 11, page 327)—the Southwark piers nevertheless represent the best yet built by the city, are unusually wide and light, and are of further interest in that while they are virtually alike in size, appearance and facilities, their substructures are unlike, typifying two of six types investigated by the Department of Wharves, Docks and Ferries. Both piers are of the general Philadelphia type of construction (see abstract of paper, "American Wharf Design," by W. J. Barney, in the Engineering Record of Oct. 3, 1914, page 382), with reinforced-concrete substructures extending down only to low water, and carried on wooden piles. The superstructures are of structural steel, with reinforced-concrete facing.

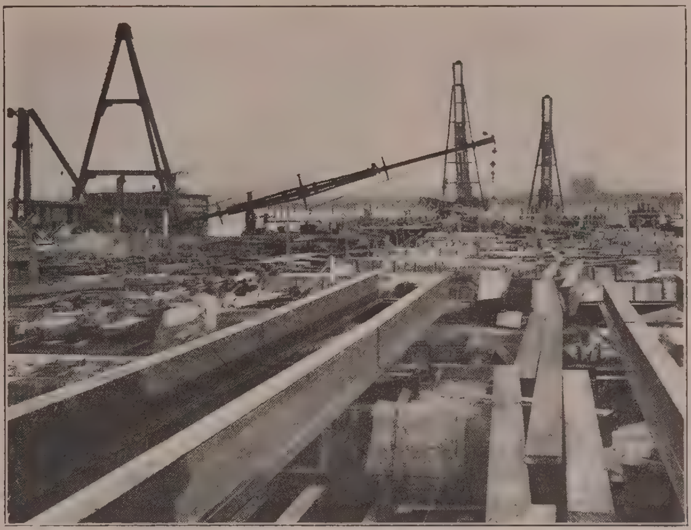
The Southwark piers, otherwise known as piers 38 and 40, are located along the Delaware River at the foot of Queen and Christian Streets. They are 550 ft. long, 180 ft. wide and 200 ft. apart in the clear—not as wide as the department advocates, but as wide as the available space would allow, and much wider than is commonly found. The piers have two decks, with numerous elevators and chutes of various kinds between decks. Two railroad tracks down the middle of each pier connect direct with the belt line on Delaware Avenue, and the lower deck is raised to the level of the car floor by ramps at the shore end. The floors are designed for unusually heavy loading, 600 lb. per square foot on the lower deck and 400 lb. on the upper. Other features of the structures are the cargo-hoist frames projecting above the roofs, and running the full length of the piers, the unusual pro-



HALF SECTIONS OF TWO SUBSTRUCTURE TYPES—TYPE A, WITH CROSS WALLS, ABOVE—TYPE E, WITH HEAVY CROSS BEAMS, BELOW



TIMBER WORK FOR PIER 38 BEFORE PLACING OF CONCRETE



CROSS WALLS OF PIER 40 IN COURSE OF CONSTRUCTION

vision for light and the architectural effects produced in the concrete head walls.

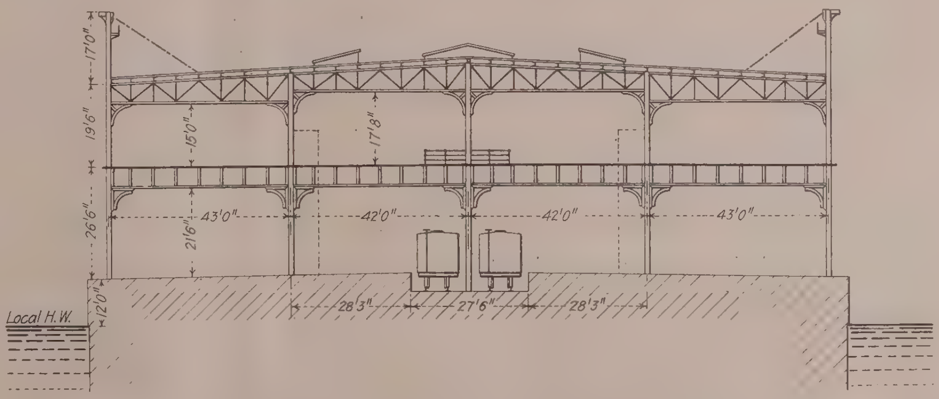
TWO SUBSTRUCTURE DESIGNS CHOSEN FROM SIX INVESTIGATED

Sixteen months ago, before the piers were started, bids were asked on five different designs of substructure. Of the five, and the sixth submitted by one of the bidders (see Engineering Record of June 6, 1914, page 638) it was found that while the cheapest was that using pile bents carried up above low water to the floor level, the possible saving was not sufficient to justify such a short-lived structure; and while the bulkheaded solid-fill types were shown to be the cheapest for piers 200 ft. wide or wider, for the 180-ft. width the types depending wholly on concrete above low water were shown to have the advantage. Two of these types—type A, using cross walls on submerged timber platforms, and type E, using concrete pedestals connected by heavy concrete cross beams, showed so little difference in cost that it was decided to build one of each. Pier 40 is of type A and pier 38 is of type E. The superstructure for the connecting bulkhead shed, which is 35 ft. wide and one-story only, is also of type E.

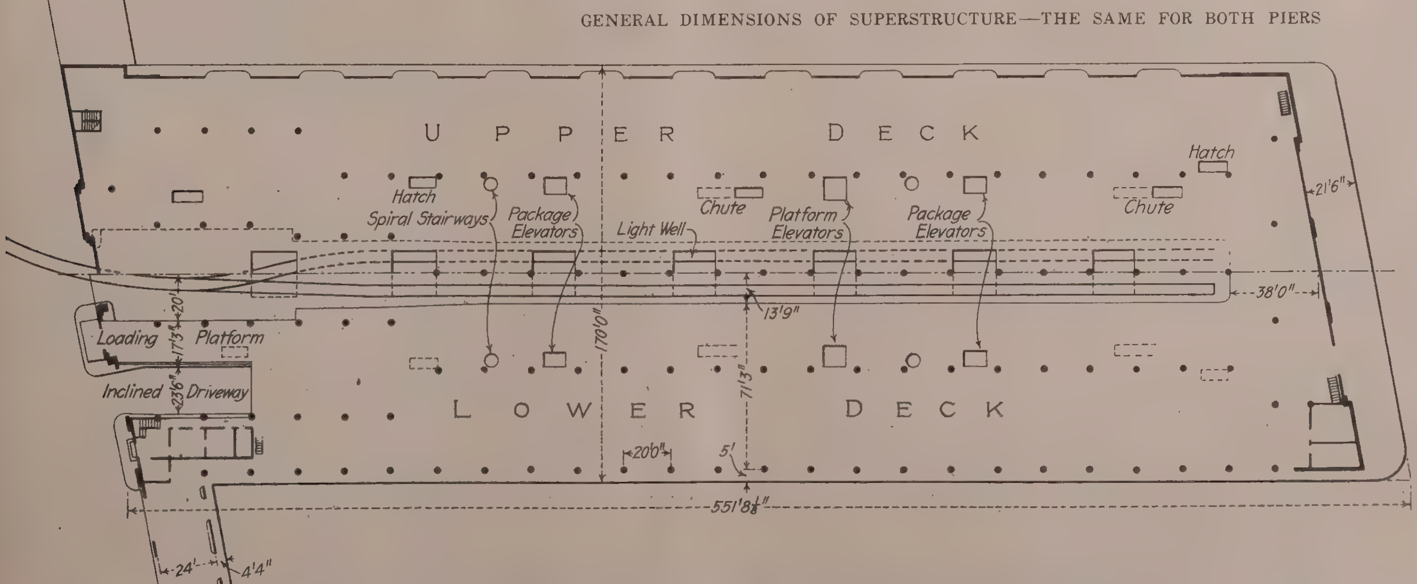
Typical transverse half-sections of the substructures of the two piers are shown. In pier 38 heavy pedestals come under the outside and quarter-way columns, lighter pedestals come midway between these, while elongated masses of concrete carry the center columns and the tracks. The bases of the exterior pedestals are 7 x 11 ft., the next set are 7 x 7, those carrying the quarter-way columns are 10 x 11, and the long sections under the tracks are 4 ft. 8 in. wide except where they widen for the center columns. The supporting piles are bedded in the concrete, which is further held by a 2-in. yellow-pine decking. The cross walls in pier 40 are uniformly of the section shown, except at the ends, where they are of the enlarged section shown. They require a heavier supporting platform, the decking being 3 in. In both types the bents are spaced 20 ft. on centers.

One of the photographs shows the pile and timber foundation of pier 38 before the placing of the concrete. The various sizes of pedestals required different numbers of piles in clusters, the total number per bent being 120 vertical and from sixteen to twenty spur piles. Pier 40, on the other hand, with a double row of piles the full length of each cross wall, but with fewer piles under the columns, required 126 vertical and from sixteen to twenty spur piles per bent.

Another difference in the two types is in



GENERAL DIMENSIONS OF SUPERSTRUCTURE—THE SAME FOR BOTH PIERS



HALF-PLANS OF BOTH DECKS—MUCH CARE WAS GIVEN TO LOCATION OF ELEVATORS, CHUTES AND LIGHT WELLS

SIDE VIEW OF PIER 38, MAY 27—NOTE CARGO HOIST RISING ABOVE ROOF

the spacing of the floorbeams. This is made 5 ft. 3 in. in pier 38 to bring an even number of beams in each 21-ft. panel, but in pier 40, where the panels are 42 ft., the beams are spaced 4 ft. 8 in., making nine to the panel, and are consequently lighter. Details are shown of a typical girder and beam of pier 38.

In both types the bents are braced by arches at the pier face as shown in one of the photographs, and by timber at various intervals at the water level.

TRACK RAILS DIRECTLY ON I-BEAMS

Originally it was intended to lay the center tracks in the usual way on crossties across the I-beam supports, but it was afterward decided to lay them as shown directly on the I-beams. They are fastened by pairs of hook bolts spaced every 2 ft. Details are shown of the combination beams and walls which form the sides of the depressions for the tracks. It will be noted that in pier 40 an I-beam is used at the base, while in pier 38 it is not.

The piers project riverward 21 ft. beyond the ends of the pier sheds. The two piers are similarly constructed at this point. A heavy (6-in.) pile-supported platform the full width of the strip carries a wall under the end of the shed and another at the end of the pier, and the intervening space is filled with earth and paved with a 4-in. concrete slab.

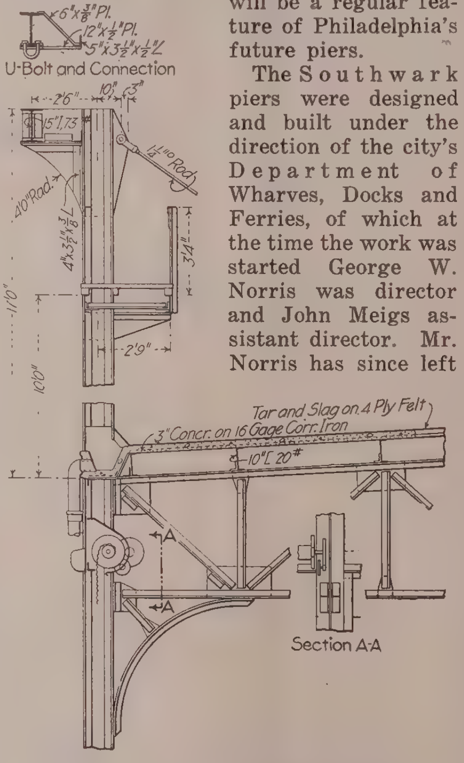
SUPERSTRUCTURES

In general the pier sheds are of standard mill-building construction. The girders carrying the upper deck are designed for possible future tracks, but the floorbeams are uniformly designed for a loading of 400 lb. per square foot, and if the tracks were laid the beams under them would have to be replaced by heavier ones. Features of the superstructure are the numerous platform and package elevators, chutes, hatches and stairways, which are shown on the general plan and make for the economical operation of the piers; the openness of the sides of the sheds giving virtually one continuous doorway on the lower level, and wide openings on the upper; the cantilevering of the upper deck out through the doorways to facilitate loading; the large skylights, and the light wells under them in the upper deck, making both decks very light; the ornamental concrete work at the ends of the sheds, shown in one of the photographs; the roof design, in which corrugated iron laid directly on the purlins carries the concrete roof slab, and the cargo hoist.

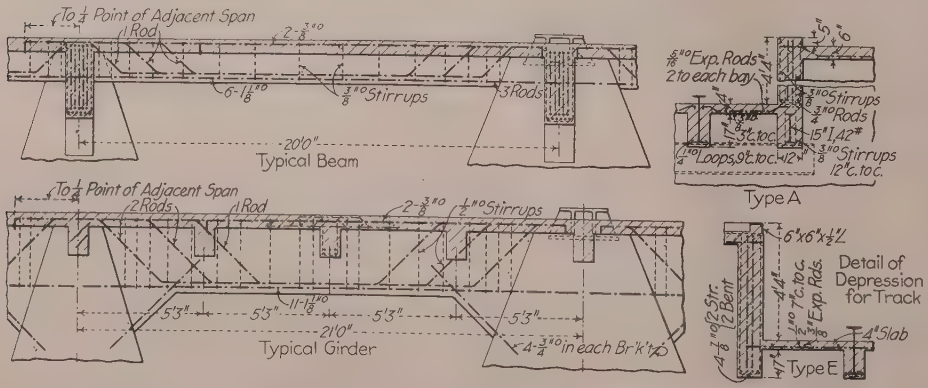
CARGO HOIST

Details are shown of the cargo hoist. The U-bolts are spaced 6 ft. each side of each bent, bringing them 8 and 12 ft. apart respectively. The Bethlehem girder beam supporting them is braced between bents by ½ x 3-in. diagonal bars in addition to the bracing furnished by the plates holding the U-bolts. This arrangement of U-bolts to which hoists may be attached at any point along the pier, convenient access being afforded from the walkway, has been accepted in both Philadelphia and New York as one of the most flexible and effective devices to facilitate the transshipment of cargo, and will be a regular feature of Philadelphia's future piers.

The Southwark piers were designed and built under the direction of the city's Department of Wharves, Docks and Ferries, of which at the time the work was started George W. Norris was director and John Meigs assistant director. Mr. Norris has since left the department and Mr. Meigs has become director. The contractor for the construction work was Snare & Triest, Inc., of New York City.



ROOF AND CARGO HOIST DETAILS



BEAMS AND GIRDERS, PIER 38—DETAILS OF DEPRESSIONS FOR TRACK

Idaho Court Overrules Depreciation Deduction

State Supreme Court, in Pocatello Water Case, Says Deterioration May Be Ignored If Plant Is in Good Operating Condition

THIS JOURNAL has repeatedly contended that the depreciation of the physical plant of a public utility, so long as service remains unimpaired and there has not been utter failure to provide for the necessary renewal of large units, is purely a stockholders' liability, and should not be deducted from cost figures to determine value. Support to this contention seems to be given by a recent decision of the Idaho Supreme Court relative to the Pocatello Water Company. The decision reversed the State Public Utilities Commission, who had deducted $77,000 for so-called "accrued depreciation." Believing in the reproduction-cost-less-depreciation principle for this class of cases, the court nevertheless saw no conflict between this principle and the disregarding of theoretical depreciation unaccompanied by deterioration of service. The court said in part:

"So far as the question of depreciation is concerned, we think deduction should be made only for actual tangible depreciation, and not for theoretical depreciation, sometimes called 'accrued depreciation.' In other words, if it be demonstrated that the plant is in good operating condition and giving as good service as a new plant, then the question of depreciation may be entirely disregarded."

DEPRECIATION THE INVESTOR'S LIABILITY

The decision of the court practically sustains the minority report of A. P. Ramstedt of the commission, in which he said:

"Physical depreciation, resulting from use, decay and the action of the elements, is a constant factor commencing simultaneously with construction and ending with replacement. A person having invested his money in a continuous business enterprise for the benefit of others must always be ready to replace the constructive portions of his plant as they wear out. A person having embarked on such an enterprise is justly entitled to compensation to cover this depreciation in addition to a fair return, over and above expenses, upon the reasonable value of the property. Allowance for depreciation cannot, in my judgment, be considered as profit or an earning factor in the business. The fact that the amount he has received from the public at any time is either greater or less than the amount which he has expended for replacements, if the allowance for depreciation is correctly computed, does not affect the returns to which he is justly entitled on his original investment. He is entitled to a fair return on his investment and to hold the undepreciated property, or its equivalent in value, which he has employed for public use.

"The fact that in an investigation of the petitioner's property, undertaken at this particular time, for the purpose of fixing rates, it is found that the market value of his physical property employed for public use has depreciated $77,188.39 does not, in my judgment, justify the commission, in its determination of a fair value for rate purposes, to deduct the amount of depreciation from the present estimated cost of reproducing the property new, and thereby reduce the earning power of his property. The petitioner has undoubtedly in the past twenty years made such replacements from time to time as the public service demanded, and must at all times be prepared to make such replacements as the public service justly demands. I cannot see how we can justly decrease the earning power of his property by decreasing the investment on which he may earn a fair return. Whenever the time comes when any great amount of replacement is necessary, and that may be at any time, he may be required to expend all that he has ever received to cover depreciation, besides a good portion of his earnings."

A Whalebone Sidewalk

THE accompanying photograph shows a sidewalk, made from the bones of whales, in front of the old San Carlos Mission at Monterey, Cal. The structure was built in 1794, but no records are available to show when the sidewalk was laid. Tradition has it that the walk was laid at the same time as the structure was built or shortly thereafter. The pieces in the foreground in the accompanying view are vertebræ, but long bones are also used, and in fact are employed for working out various designs in the sidewalk. Of course, there is only pedestrian traffic over it.

The gentleman at the extreme left of the picture is the city engineer of San Francisco, M. M. O'Shaughnessy, while the nearer of the two figures in the center is José R. Villalon, commissioner of public works of Cuba.

WHALEBONE SIDEWALK LAID IN 1794

Milwaukee's Activated Sludge Plant the Pioneer Large-Scale Installation

T. Chalkley Hatton, Chief Engineer of Sewage Commission, Discusses Design of New Works and Probable Operating Costs

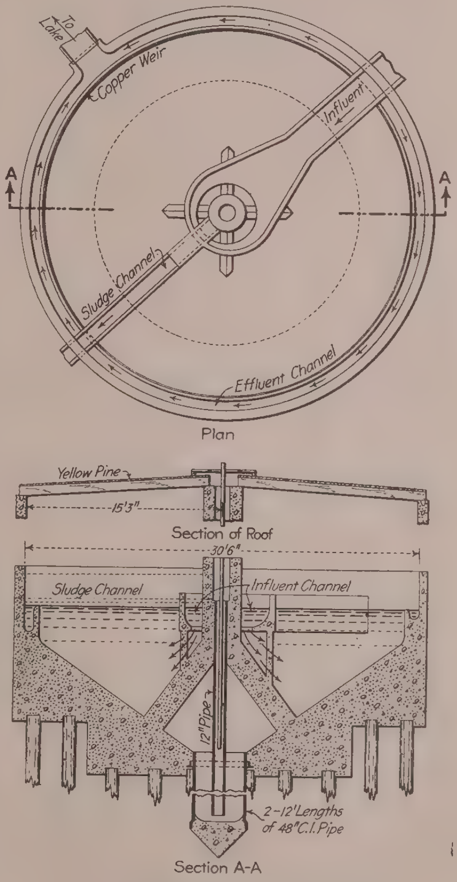
BASING a decision on the results of experimental work costing $65,000, the Milwaukee Sewerage Commission is building the world's pioneer large-scale plant for the treatment of sewage by the activated sludge process. The new works comprise eleven circular 30-ft. concrete tanks of the continuous flow type, designed to treat 1,600,000 gal. of sewage daily with a 4-hr. period of aeration and a 25 per cent activated sludge content. A feature of the plant is the diffusion of air at the tank bottoms by porous quartz sand plates. The works, which are being constructed for the purpose of trying out the process on a normal size unit, so that the city may be guided in the ultimate expenditure of $3,000,000 on its sewerage system, were described by T. Chalkley Hatton, chief engineer of the Milwaukee Sewerage Commission, at the convention of the American Society of Municipal Improvements, held in Dayton, Ohio, this week. The following extracts are from Mr. Hatton's paper:

EXPERIMENTS INDICATE SUCCESS OF CONTINUOUS FLOW TANK

The operation of experimental tanks, placed in operation last March, clearly demonstrated that it was possible to treat the sewage of Milwaukee by the activated sludge process on the fill-and-draw method, when the temperature of the sewage was 50 deg. Fahr. or more, at less cost than by any other process with which the commission had been experimenting, taking into consideration the character of effluent obtained. Having determined the availability of the fill-and-draw method, it was determined to try the continuous flow method. Activated sludge was obtained for seeding this tank partially from the Imhoff tank and from fresh sewage. The Imhoff tank sludge, which is anaerobic and which must be converted into aerobic sludge before activated sludge is produced, was run into the new tank; to this was added fresh sewage every 8 or 10 hr., and the mixture aerated by blowing air through it under about 5 lb. pressure. At the end of 6 or 8 hr. the air was turned off, sludge allowed to settle, the supernatant liquor drawn off, fresh sewage added to the capacity of the tank and the aeration repeated.

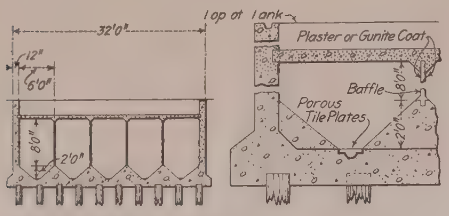
This process was continued until the tank contained about 30 per cent of its capacity of good activated sludge. It required about 33 days to seed this tank in the manner described, whereupon it was started upon the continuous flow method. This was begun during the first week in July of this year and has been continued without material interruptions since.

From the beginning of the tests remarkable results were secured, according to Mr. Hatton. With a rough screened sewage containing from 1,000,000 to 7,000,000 bacteria per cubic centimeter, 250 p.p.m. of suspended matter, 30 p.p.m. organic nitrogen and 120 p.p.m. oxygen consumed, an effluent was produced containing a 99 per cent removal of bacteria and suspended matters, 12 to 14 p.p.m. nitrates, stable after 5 days and clear as the lake water, leaving a sludge containing 5.45 per cent of ammonia, 1.34 per cent of available phosphoric acid and 0.23 per cent of potash, worth as a fertilizer $9 a ton based on dry weight.

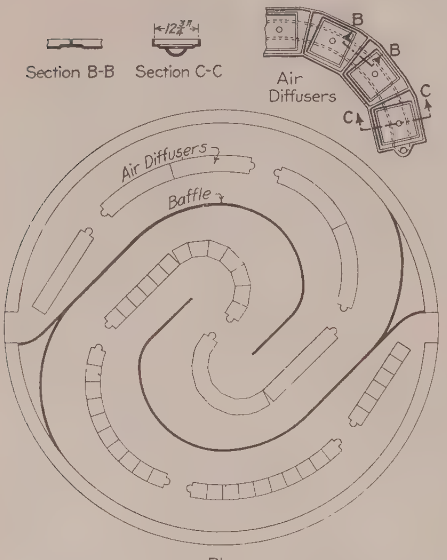


SEDIMENTATION TANK DETAILS

This was accomplished with 1.77 cu. ft. of air per gallon of sewage treated, costing $4.43 per million gallons based on air at $2.50 per million cubic feet compressed to 5 lb. pressure, which is the guaranteed cost where large units are used, and includes all overhead charges and boiler room labor, but not outside plant or engine room labor. Experiments now under way indicate that the volume of air can be very much reduced. In considering the cost of this process the character of effluent obtained must not be lost sight of. The effluent above described is of far higher standard than any yet obtained from any of the processes with which experiments have been conducted at



ARRANGEMENT OF BAFFLES AND AIR DIFFUSER PLATES



BAFFLES DIVERT FLOW OVER AIR DIFFUSERS IN TANK BOTTOM

the Milwaukee testing station, and much higher than is ordinarily required. If the standard is reduced the cost will be reduced in direct ratio.

In view of the foregoing record of results obtained by this process, either by the fill-and-flow or continuous flow method it is not surprising that the Sewerage Commission felt warranted in expending $65,000 trying out the process on a large size unit, before adopting it as a plant which would ultimately cost in the neighborhood of $3,000,000.

One of the principal reasons for building the large unit was to determine how much low temperatures of the winter would affect the process, what methods would have to be used to overcome this effect and what they would cost. The foregoing results have all been obtained with sewages varying in temperatures from 50 to 70 deg. Fahr., whereas the winter sewages run down to 42 deg. Fahr. for short periods. It is well known that low temperatures seriously affect the efficiency of nitrifying organisms, but to what extent cannot be determined until a fair trial is made, and the contemplated plant may show that some artificial heat will have to be applied to some portion of the process during the extreme low temperature periods.

Description of Plant

The plant consists of eleven circular reinforced-concrete tanks 30 ft. inside diameter by 13 ft. maximum depth, supported upon a pile foundation due to the instability of the soil. Tanks 1 to 6, inclusive, are the aerating tanks in which the sewage mixed with the activated sludge is aerated by means of air forced in under 5 lb. pressure. Tank 9 is the sedimentation tank, and tanks 10 and 11 are the activated sludge tanks. The drawings show details of the aerating tanks with their curved baffles, the manner of sloping the bottom of the running through channels so as to avoid the deposition of sludge, and the manner of placing the air diffusers. The sedimentation tank is the only tank to be roofed over. The roof is necessary to prevent ice forming about the edges of the circular weir, which would set up uneven currents. This tank has a radial flow, and is designed for a 25 min. sedimentation period at a 2,000,000-gal. rate.

The two sludge tanks are similar to the aerating tanks except that they are each made into two separate compartments by stop planks connecting the two ends of the baffle walls. Their pipes and diffusers are placed in the same number and manner as in the aerating tanks.

Wooden rectangular troughs are built part way around each tank to control the direction of the flow of liquor, and stop planks are arranged so that any one or series of tanks can be cut out. The sewage from 250,000 people, to which is added the sewage from the packing house district, passes out to the lake through a 20-ft. wide open channel alongside of the proposed plant.

In this channel a weir is constructed 20.35 ft. long, which maintains a depth of about 3 ft. of liquor for 40 ft. back of the weir. This is the grit chamber in which the heavier solids from the street washings are deposited, as the sewers connected with this large intercepting sewer are of the combined type. The weirs have been so arranged as to provide a flow through the plant to correspond with the fluctuations of flow through the main sewer, and the air applied to the sewage will be automatically regulated to correspond with this flow. Self-recording air meters will be installed to determine the volume and pressure of air used.

The sewage, after passing the plant weir, enters tank 1, where it comes into immediate contact with the air and the activated sludge, with which the tank has been originally seeded. It is designed to use 25 per cent of this activated sludge at first and to increase or diminish it as the operation shows necessary to get the most economical results.

Passing through tank 1 the liquor, mixed with the sludge, enters tank 2, when it is again aerated and further mixed with the sludge contained in that tank, and so continues until it passes, with the sludge mixed with it, into the center channel of tank 9. Here the sludge settles out to the bottom of the tank, the clear liquor passing

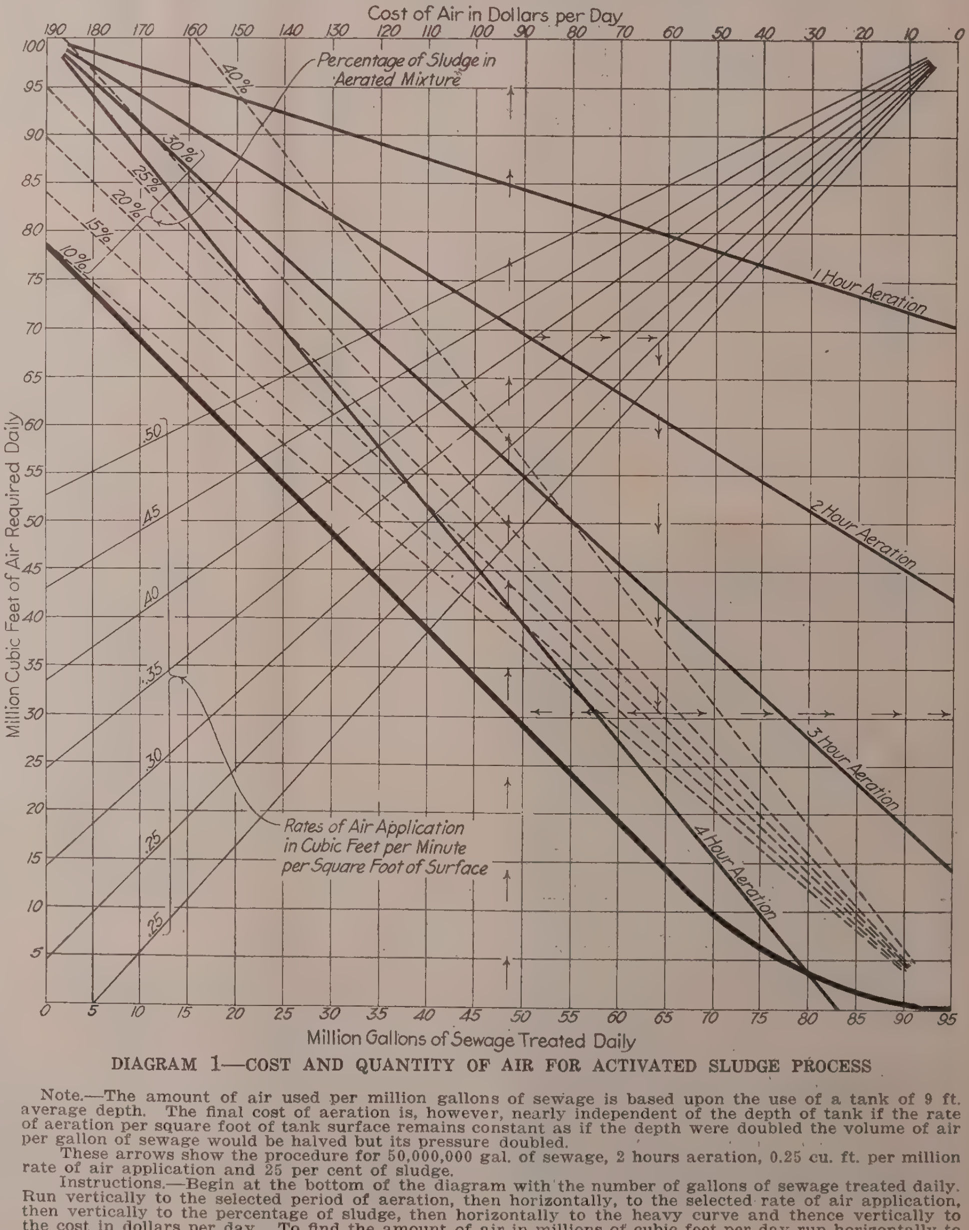


DIAGRAM 1—COST AND QUANTITY OF AIR FOR ACTIVATED SLUDGE PROCESS

Note.—The amount of air used per million gallons of sewage is based upon the use of a tank of 9 ft. average depth. The final cost of aeration is, however, nearly independent of the depth of tank if the rate of aeration per square foot of tank surface remains constant as if the depth were doubled the volume of air per gallon of sewage would be halved but its pressure doubled.

These arrows show the procedure for 50,000,000 gal. of sewage, 2 hours aeration, 0.25 cu. ft. per million rate of air application and 25 per cent of sludge.

Instructions.—Begin at the bottom of the diagram with the number of gallons of sewage treated daily. Run vertically to the selected period of aeration, then horizontally, to the selected rate of air application, then vertically to the percentage of sludge, then horizontally to the heavy curve and thence vertically to the cost in dollars per day. To find the amount of air in millions of cubic feet per day run horizontally to the left instead of to the heavy curve.

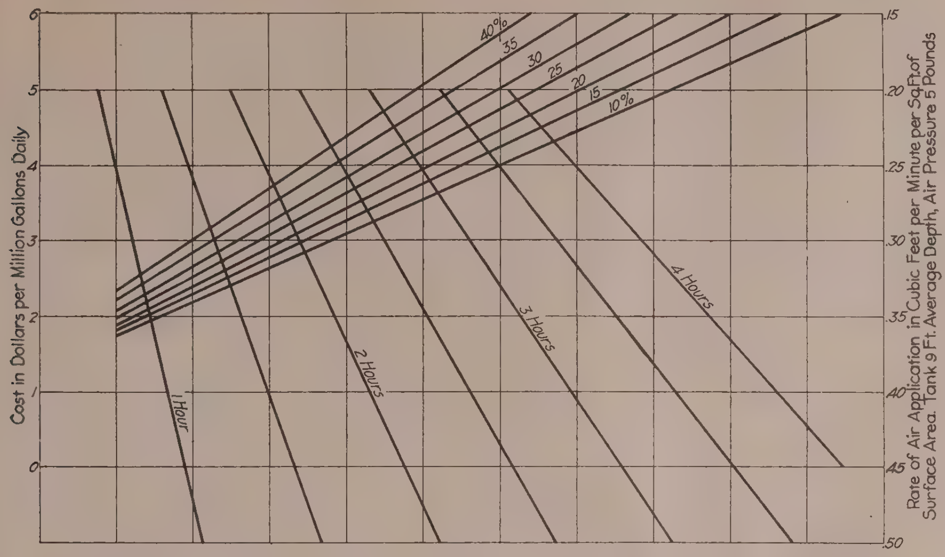


DIAGRAM 2—COST OF ACTIVATED SLUDGE TREATMENT FOR 50,000,000 GALLONS

Note.—Costs as shown embrace all operating costs, interest charges and operating costs including boiler room labor, but excluding engine room and plant labor. Tankage is provided for 1½ times the average daily flow and the sedimentation period is ½ hour. Pumping of sludge is figured in as 30c per million gallons of sludge pumped on the basis of 10c per million gallons one foot high.

Instructions.—Select the required rate of air application on vertical line to the extreme right. Run from this point horizontally to the left to the required period of aeration, then run vertically to the required percentage of sludge in the mixed liquor, and thence horizontally to the left for the cost in dollars per million gallons of sewage treated.

over the circumferential weir to the lake.

The sludge settles to a deep well built in the bottom of the settling tank, and is discharged by gravity into sludge tanks 10 or 11, where it is aerated for such a period as may be necessary to maintain the nitrogen cycle. From these sludge tanks the sludge passes to an 18-in. cast-iron pipe sunk vertically in the ground with its base about 28 ft. below the height of the liquid in the sludge tank, and from this pipe it is pumped by air into the fresh liquor trough, entering tank 1 with the raw sewage and again passing through the process.

That portion of the activated sludge in excess of what is necessary to maintain the proper percentage in the aerating tanks is pumped out of the sludge tanks from time to time and dewatered and will be used as a fertilizer. The method of dewatering has not yet been decided upon, but will probably be by means of the sludge press or vacuum wheel. The deep chambers connected with the settling tank and sludge tanks are for the purpose of dewatering the sludge as much as possible by weight, and thus avoiding the pumping of unnecessary liquor through the process.

It has been found by the experiments conducted that the success of the continuous flow method depends upon maintaining good activated sludge at all times in the tanks treating the fresh liquor. By aerating the sludge to a higher degree than the whole body of the liquor, air is saved because only 25 per cent of the entire mixture is thus given an additional aeration.

The plant, as designed, can treat 1,600,000 gal. of sewage per day with a 4-hr. period of aeration and with a 25 per cent activated sludge content. From present indications it will be able to treat the sewage satisfactorily, when the temperature is 50 deg. Fahr. or over, at a much higher rate, but this is yet to be determined on the large scale. In order to overcome some of the effects of low temperature it is designed to pass the condensing water from the present sewage station adjacent to the new plant through coils of pipe hung to the inside perimeter of the two sludge tanks, inducing circulation by a circulating pump built in the condenser discharge line. This water is now discharged into the river at a temperature of about 100 deg. Fahr.

The power plant for producing the air necessary for operating the plant consists of two positive pressure rotary blowers each having a capacity of 2400 cu. ft. of free air space per minute compressed to 6 lb. pressure and belt driven from two alternating current variable speed motors each of 75 b.h.p. Only one unit will be required for operating the plant. Two are provided to avoid possible interruptions.

One of the questions which would immediately arise in the mind of the engineer is why were circular tanks designed in preference to rectangular. These tanks were designed before any results had been obtained from the continuous flow method, and Mr. Hatton felt there were only two processes available for satisfactorily treating the sewage of Milwaukee. The activated sludge process with continuous flow or fine screening followed by Imhoff tank sedimentation, followed by chlorination. If the former process proved a failure the latter would have to be adopted. The tanks were therefore designed so that they could be used as the digestion chambers for an Imhoff tank installation by removing the sloping bottoms and baffle walls.

RECTANGULAR TANKS BEST

It is quite probable that rectangular tanks will better fit the conditions required to carry on the process. One advantage is that the air diffusers can be placed across such a tank at right angles to the direction of flow, thus avoiding possible short circuiting of the liquor; another is the better convenience of placing the air piping system and avoiding placing any pipes in concrete; and a third is cheaper forms for construction. But whatever form of tank designed the width of the running-through channel should not exceed 6 to 8 ft. to get the most economical disposition of the air.

Many experiments have been conducted with a view of determining the best form of air diffuser, and others are now being carried on. So far the Filtros plate seems to give the best result. This is a composition of quartz sand and some character of cement to bind it together. The sand is ground to an uniform coefficient to give any desired porosity and, after adding the cement, is burned in a furnace. The plates come any size or shape desired and at any thickness. In the Milwaukee plant a plate 12 in. square by 1½ in. thick is being used and has a capacity for passing 2 cu. ft. of air per square foot at 2 in. water pressure. The porosity is 33.27 per cent by voids. This material is manufactured by the General Filtration Company, Inc., of Rochester, N. Y.

It has been found very important to maintain as far as possible an even diffusion of air throughout the body of the liquor. That is, every square foot of plate should contribute its share of free air. To this end orifices are provided to be set in the casting under each Filtros plate. Each orifice is designed to pass the required volume of air under a predetermined pressure.

COST

Of course one of the most important factors to be determined in treating sewage by the activated sludge process is the cost, and the writer presents herewith an estimate of the cost so far as it has been determined from the experiments so far conducted.

In considering this phase of the question it should be first realized that such effects upon cost as low temperatures might have has not been determined; that, with this exception, sufficient data have been secured to accurately determine how much air is required to treat the sewage and sludge to produce a certain standard of effluent from the Milwaukee sewage, and guarantees from well-known manufacturers of blowers, engines, turbines and motors have been secured as to the efficiency of the several apparatus they will undertake to furnish for the final treatment plant.

General dimensions of aerating, sludge and settling tanks have been determined with reasonable accuracy based upon the various periods of aeration and sludge content shown upon the diagrams. These diagrams have been prepared for determining the cost of treating a daily average of 50,000,000 gal. of sewage at Milwaukee, with coal worth 1 cent per 82,000 B.t.u, the price now being paid by the City Water Department, but from the diagrams the cost for other rates of flow can be determined.

It is clearly demonstrated, however, that the smaller the plant the higher the cost for treatment due to the less efficiency in operating small-size blowers, and reciprocating engines and small motors instead of large-size blowers, steam turbines or large motors. It may be that this cost can be considerably reduced by using oil or gas engines in driving the smaller units.

Diagram 1 shows the cost of producing the air per million gallons treated per day under varied conditions as to period of aeration, rate of air application per square foot of tank surface and percentage of activated sludge maintained in the tanks. This cost includes all boiler room labor and all overhead charges such as interest, sinking fund and depreciation.

Diagram 2 includes the cost of the plant for treating the sewage, which cost includes all overhead charges such as interest, sinking fund and depreciation. The only labor cost included is boiler room labor, the engine room and plant labor not being included for want of sufficient information.

These diagrams are based upon rectangular tanks holding an average depth of 9 ft. of liquor, the depth which has so far seemed most applicable to the Milwaukee situation.

In Milwaukee the most satisfactory results have been obtained by using 0.25 cu. ft. of air per minute per square foot of tank surface, a period of 4 hr. aeration with a sludge content of 25 per cent. By referring to diagram 2 it will be seen that this treatment will cost $5.30 per million gallons treated, exclusive of engine room and plant labor and the disposal of the sludge. If a lower standard of effluent is required and a 3-hr. period of aeration only is required with 20 per cent sludge content and the same rate of air supply, the cost will be seen to be $3.95 per million gallons treated.

Mr. Hatton believes he is warranted in the statement that the above costs are much below the cost of producing an equal standard of effluent from any other process of sewage treatment applicable to a large United States municipality. It seems quite within the bounds of reason to anticipate that there will be sufficient recoverable value in the sludge to pay for its final disposition at least, so that the cost of this portion of the process need not be taken into consideration when comparing it with the cost of treating sewage by any other process.

How Consistency and Age Affect Strength of Mortar

Natural-Sand vs. Ottawa-Sand Tests Discussed in Connection with Standard Requirements for Equal Strength

TESTS of 2-in. mortar cubes made in the Materials Testing Laboratory of the Public Service Commission in New York City seem to show that Ottawa-sand mortar acquires its strength more rapidly than mortar made from natural sand, which is generally graded from fine to coarse. This fact helps to explain the erratic comparative results obtained, and is of importance in connection with the usual requirement that natural-sand should equal Ottawa-sand mortar in strength. It has further been proved by tests that the relative strengths are directly and largely affected by both consistency and age when tested.

Explanation of Erratic Results

Many cases of fine-sand specimens which were acceptable at 3 days or 7 days but failed at 28 days in comparison with standard Ottawa sand have been observed. The most notable case was a sample of fine sand which showed 141 per cent of the strength of Ottawa at 3 days, 122 per cent at 7 days and only 98 per cent at 28 days. The analysis of this sand shows the following percentages passing the sieves given: No. 4, 100; No. 8, 97; No. 16, 77; No. 30, 44; No. 50, 14, and No. 100, 4.

It is suggested that a possible explanation of erratic results is the effect of fineness and grading on time of setting and the much more rapid gain in strength of the Ottawa-sand mortar. That many sands show great variations in comparison with standard Ottawa sand has been fully proved by the very extensive tests on subway construction work made by the Materials Testing Division. The results of relative test averages for ten tests of ten specimens each show that at 3 days natural sand specimens averaged 126 per cent of Ottawa sand, at 7 days 128 per cent, and at 28 days 120 per cent. These results tend to prove that Ottawa-sand mortar acquires strength more rapidly than natural-sand mortar.

Prof. L. J. Johnson also cites a case as follows: In a sand sample the strength in tension as 1:3 mortar showed 113 per cent of that of Ottawa sand at the age of 4 days, and only 82 per cent at 28 days.

Effect of Consistency

Another cause of relative decrease in ratio at the later ages is in the consistency of the mortar; slightly wetter consistency for the natural-sand mortar has a much larger effect in decreasing the strength at early ages than at later ages, and the effect on graded-sand mortar is greater than on Ottawa-sand mortar. Satisfactory sands may sometimes be rejected due to failure to realize the effects of the consistency. The accompanying table shows the effect of a variation of only 1 per cent in the water used.

COMPRESSIVE TESTS OF 2-IN. CUBES—PROPORTIONS 1:3—CONSISTENCY, WET—AVERAGE RESULTS IN PERCENTAGE OF OTTAWA-SAND MORTAR

Age in Days	Ottawa Sand, 14.9 Per Cent Water	Natural Sand, 16.4 Per Cent Water	Natural Sand, 15.4 Per Cent Water
3	100	122	148
7	100	119	117
28	100	112	111

Owing to the above-mentioned causes of variation, the sands tested by the Materials Testing Division are not rejected if they fall within the following limits below the strength of mortar cubes of Ottawa sand: 10 per cent at 4 days; 5 per cent at 7 days, and 1 per cent at 28 days. The operators have been instructed to guard against the effects of wetter consistency in the natural-sand specimens by always making them slightly drier than the standard Ottawa-sand specimens.

Form Proposed for Federal Valuation Report

Ready Comparisons of the Net Results of All Conflicting Theories the Aim of the Skeleton Tables Suggested

By D. F. JURGENSEN
Engineer, Minnesota Railroad and Warehouse Commission, St. Paul

SO MANY perplexing questions are involved in the completion of the task imposed upon the Interstate Commerce Commission by the valuation act that it would seem advisable to prepare a tentative form of inventory which might be used for the purpose of classifying the various methods now being proposed for the purpose of arriving at the ultimate question, "fair value." Some hold that "fair value" should be determined by the so-called "reproduction or replacement" method, and the advocates of this method are again divided into those who assert that reproduction implies allowances for cost of acquisition, consequential damages, contingencies, engineering expenses, interest during construction and many other items, while others contend that the "cost of reproduction" should be limited to the ascertainment of the present value of the items of property actually in existence, which it is held is the true interpretation of the decision of the U. S. Supreme Court in the Minnesota rate cases.

Another controversy has arisen with reference to the purpose to be served by the valuation, or to what use the valuation may be put after it is made. In this connection there seems to be a difference of opinion whether or not the term "fair value" means one amount when used as a basis for rate making, and another amount when used as a basis for sale or condemnation, and perhaps still another when used as a basis upon which to adjust capitalization.

Inventory to Express Views of All

The inventory on the opposite page aims to suggest a form in which each of these views, as well as other contentions not necessary to specify, may find full expression. The thought underlying the suggestion is that in advance of the ascertainment of all of the facts and circumstances it is difficult, if not impossible, to come to a definite conclusion as to the propriety of the contentions advanced, or the proper solution of the problem involved. If, however, an inventory of the property was prepared which would place in parallel columns the facts and items depended on to substantiate each contention advanced, it would, it is submitted, go a long way toward the solution of the question, and would, at least, simplify the work of the commission.

The accompanying inventory is naturally a mere skeleton; the amounts used for illustration have been arbitrarily selected. The inventory is not presented as an actual inventory of the property of any carrier, nor is it at this time presented as the final inventory or tabulation to be adopted by the commission. It is suggested as a "working form," and one which is probably adapted to be used for the tentative or proposed valuation specified in the valuation act, to be first submitted by the commission for criticism and to be perhaps modified after the hearing provided for in the act.

Explanation of Forms

The first four columns of Sheet 1 are self-explanatory. Column 5 applies only to transportation lands. Column 6 gives the "cost of reproduction new" of all properties, including items contended for by those who advocate the inclusion of cost of acquisition. Column 7 records "present value new" of physical properties in existence and devoted to or held for transportation business. Column 8 gives actual existing depreciation in the transportation plant as compared with the plant if it were new, and column 9 records the total "actual present value" of the transportation plant, based on columns 7 and 8.

Columns 2 to 6 refer to all property owned by the carrier; the subsequent columns refer only to that devoted to or held for transportation purposes. The total amount of this property is found in column 7, and in the subsequent columns deductions are made upon different bases, each column showing the total actual "present value" of the items included upon the particular basis used for that column.

It is proper to say that each column in Sheet 1 subsequent to column 9 is based upon actual present value as given in column 9, and that the basis adopted for column 6 has not been carried into any of the subsequent tabulations.

Sheets 2, 3, 4, 5 and 6 are analyses of the items found in Sheet 1, and require no detailed explanation.

SHEET 1—PROPOSED SKELETON FORM TO BE USED IN PREPARATION OF "TENTATIVE VALUATION OF COMMON CARRIER PROPERTY" SPECIFIED IN VALUATION ACT OF MARCH 1, 1913

ALL PROPERTY OWNED						PROPERTY DEVOTED TO OR HELD FOR TRANSPORTATION BUSINESS											
		COST OF REPRODUCTION NEW						ACTUAL PRESENT VALUE									
Item	Original cost	Appreciation	Present value new	Cost of acquisition and consequential damages	Total	Present value new, as in col. 4	Depreciation	Total	As in col. 9, omitting granted right-of-way and land held for future	As in col. 10, carrying easements at cost	As in col. 11, omitting construction and equipment acquired from operating expenses	As in col. 12, omitting construction and equipment acquired from surplus earnings	As in col. 13, omitting adaptation and solidification of roadbed	As in col. 14, omitting construction and equipment donated by counties and municipalities			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1—*Lands* devoted to transportation business (classifiable under I. C. C. classification "I—Road")	$3,000,000	$6,500,000	$9,500,000	$12,000,000	$21,500,000	$9,500,000		$9,500,000	$7,350,000	$7,000,000	$7,000,000	$7,000,000	$7,000,000	$7,000,000			
2—*Construction* (including all items under I. C. C. classification "I—Road", except *Land*)..........	15,000,000	*14,500,000	27,900,000		*29,500,000	27,900,000	$5 300,000	*24,200,000	24,200,000	24,200,000	21,400,000	17,400,000	15,800,000	11,800,000			
3—*Equipment* (including all items under I. C. C. classification "II—Equipment")..........	9,600,000	3,400,000	13,000,000		13,000,000	13,000,000	3,900,000	9,100,000	9,100,000	9,100,000	8,330,000	7,730,000	7,730,000	6,870,000			
4—*III—General Expenditures* (as in I. C C. classification "Investment in Road and Equipment").	700,000	3,900,000	4,600,000		4,600,000												
5—*Miscellaneous Properties Owned* (but not devoted to transportation business).............	13,430,000	28,700,000	42,130,000		42,130,000												
Totals.............	$41,730,000	$57,000,000	$97,130,000	$12,000,000	$110,730,000	$50,400,000	$9,200,000	$42,800,000	$40,650,000	$40,300,000	$36,730,000	$32,130,000	$30,530,000	$25,670,000			

*Includes $1,600,000 for "adaptation and solidification" of roadbed. See Sheet 3. Adaptation and solidification do not obtain in a new roadbed and are therefore omitted in columns 4 and 7.

SHEET 2—ANALYSIS OF ITEM 1—LANDS DEVOTED TO TRANSPORTATION PURPOSES—(CLASSIFIABLE UNDER I. C. C. CLASSIFICATION "I—ROAD")

How obtained	Original cost	Present value	Cost of acquisition and consequential damages	Cost of reproduction new
1	2	3	4	5
Granted......	Nil	$1,500,000	$3,000,000	$4,500,000
Condemned...	$100,000	400,000	400,000	800,000
Purchased and used.......	2,600,000	6,900,000	7,900,000	14,800,000
Purchased and held for future use....	300,000	650,000	650,000	1,300,000
Easements in public streets	Nil	50,000	50,000	100,000
Totals......	$3,000,000	$9,500,000	$12,000,000	$21,500,000

SHEET 4—ANALYSIS OF ITEM 3—EQUIPMENT—(INCLUDING ALL ITEMS UNDER I. C. C. CLASSIFICATION "II—EQUIPMENT")

How obtained	Original cost	Present value new	Depreciation	Actual present value
1	2	3	4	5
Capital account	$8,000,000	$9,810,000	$2,940,000	$6,870,000
Surplus earnings	700,000	870,000	270,000	600,000
Operating expenses.......	900,000	1,100,000	330,000	770,000
Cash donations from counties and municipalities......	Nil	1,220,000	360,000	860,000
Totals.......	$9,600,000	$13,000,000	$3,900,000	$9,100,000

SHEET 6—ANALYSIS OF ITEM 5—MISCELLANEOUS PROPERTIES OWNED BUT NOT DEVOTED TO TRANSPORTATION BUSINESS

Class	Original cost	Present value new	Depreciation	Actual present value
1	2	3	4	5
Lands not classifiable under I. C. C. Classification "I—Road".......	Nil	$10,000,000	None	$10,000,000
Mine property..	$70,000	700,000	None	700,000
Securities of other carriers....	7,000,000	10,000,000	None	10,000,000
Securities other than of carriers..........	1,000,000	5,000,000	None	5,000,000
Amusement resorts........	60,000	80,000	$40,000	40,000
Hotels.........	300,000	350,000	150,000	200,000
Stores and supplies........	3,000,000	3,500,000	None	3,500,000
Franchises.....	Nil	10,000,000	None	10,000,000
Unclassified assets of various kinds	2,000,000	2,500,000	None	2,500,000
Totals.......	$13,430,000	$42,130,000	$190,000	$41,940,000

SHEET 3—ANALYSIS OF ITEM 2—CONSTRUCTION—(INCLUDING ALL ITEMS UNDER I. C. C. CLASSIFICATION "I—ROAD," EXCEPT LAND)

How obtained	Original cost	Present value new	Depreciation	*Adaptation and solidification of roadbed	ACTUAL PRESENT VALUE	
					Including adaptation and solidification of roadbed	Omitting adaptation and solidification of roadbed
1	2	3	4	5	6	7
Capital account......	$10,000,000	$15,514,000	$3,000,000	$886,000	$13,400,000	$12,514,000
Surplus earnings......	3,000,000	4,636,000	900,000	264,000	4,000,000	3,736,000
Operating expenses...	2,000,000	3,114,000	500,000	186,000	2,800,000	2,614,000
Cash donations from counties and municipalities............	Nil	4,636,000	900,000	264,000	4,000,000	3,736,000
Totals..	$15,000,000	$27,900,000	$5,300,000	$1,600,000	$24,200,000	$22,600,000

*Adaptation and solidification do not obtain in a new roadbed.

SHEET 5—ANALYSIS OF ITEM 4—III—GENERAL EXPENDITURES, AS IN I. C. C. CLASSIFICATION OF "INVESTMENT IN ROAD AND EQUIPMENT"

Item	Original cost	PRESENT VALUE NEW		Depreciation (On assumption that III—Gen. Exp. constitutes part of cost of physical property)	ACTUAL PRESENT VALUE	
		*Basis "A"	†Basis "B"		Basis of col. 3 and col. 5	Basis of col. 4 and col. 5
1	2	3	4	5	6	7
Organization expenses.......	$30,000	$200,000	$171,000	$34,200	$165,800	$136,800
Law expenses...	20,000	130,000	115,000	23,000	107,000	92,000
Taxes...	50,000	330,000	287,000	57,400	272,600	229,600
Interest..... ..	200,000	1,310,000	1,143,000	228,600	1,081,400	914,400
Commissions.....	300,000	1,970,000	1,713,000	342,600	1,627,400	1,370,400
Other expenses...	100,000	660,000	571,000	114,200	545,800	456,800
Totals........	$700,000	$4,600,000	$4,000,000	$800,000	$3,800,000	$3.200.000

*Basis "A" computed on cost of acquisition and consequential damages as to lands.
†Basis "B" computed on only "present value" of lands.

Reinforced-Concrete Conduit Analysis Simplified by Theory of Displacements

Conduit Designed by W. M. Smith in Engineering Record of May 22, Using Least-Work Theory, Is Here Analyzed by Shorter Graphical Methods

By C. S. WHITNEY
Steel Inspector for Gustav Lindenthal, Consulting Engineer, New York City

AN ARTICLE by W. M. Smith in the Engineering Record of May 22, page 648, described a method of applying the theory of least work to the analysis of reinforced-concrete conduits. The same problem can be solved by the graphical application of the theory of virtual displacements outlined in the writer's previous article in the issue of Sept. 11, page 234. This problem is a comparatively difficult one because of the large number of oblique forces and the shape of the section, but the true pressure line can be located quite accurately in less than twelve hours by one familiar with the graphical method.

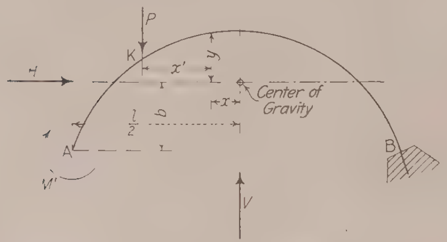


Fig. 1 – Fixed Arch Notation

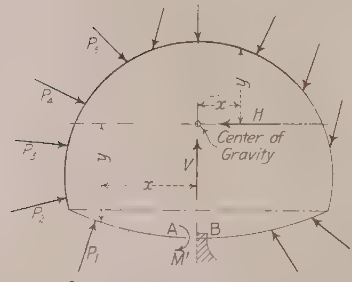


Fig. 2 – Application to Conduit

THEORY SAME AS FOR FIXED ARCH

The theory involved is the same as that explained in the article by the writer referred to above on the analysis of fixed elastic arches. The equations are similar to those there derived; H is the horizontal and V the vertical component of the reaction and M is the bending moment at the left end. Neglecting the effect of temperature, rib shortening and shear the reactions are given by the following formulas, which assume that the arch ring has been divided into small lengths so that the values of $\Delta s/EI$ are equal. (See equations 4 of previous article.)

$$\left.\begin{aligned} H &= \left(\sum_A^B M_1 y\right) \Big/ \sum_A^B y^2 \\ V &= \left(\sum_A^B M_1 x\right) \quad \sum_A^B x^2 \\ M' &= \left(\sum_A^B M_1\right) \quad n \end{aligned}\right\} \qquad (1)$$

The term M_1 is the moment at the center of the divisions of the rib produced by the external loads, excluding the reactions, on the arch rib considered as acting as a simple cantilever fixed at the right-hand end only. In the preceding article, the value of M_1 was equal to Px' because the effect of a single vertical concentrated load was being considered in order to obtain influence lines for moving loads.

It should now be observed that the arch rib may be curved completely around in the shape of a ring without in any way affecting the equations involved. If the abutments are drawn near together as in Fig. 2 at A and B, the equations for H, V and M still give the reactions at left end A. The moment M_1 is the moment of the external forces P_1, P_2, etc., about the given point x, y. The value of M, as before, is

$$M = M' + Hb - Vl/2$$

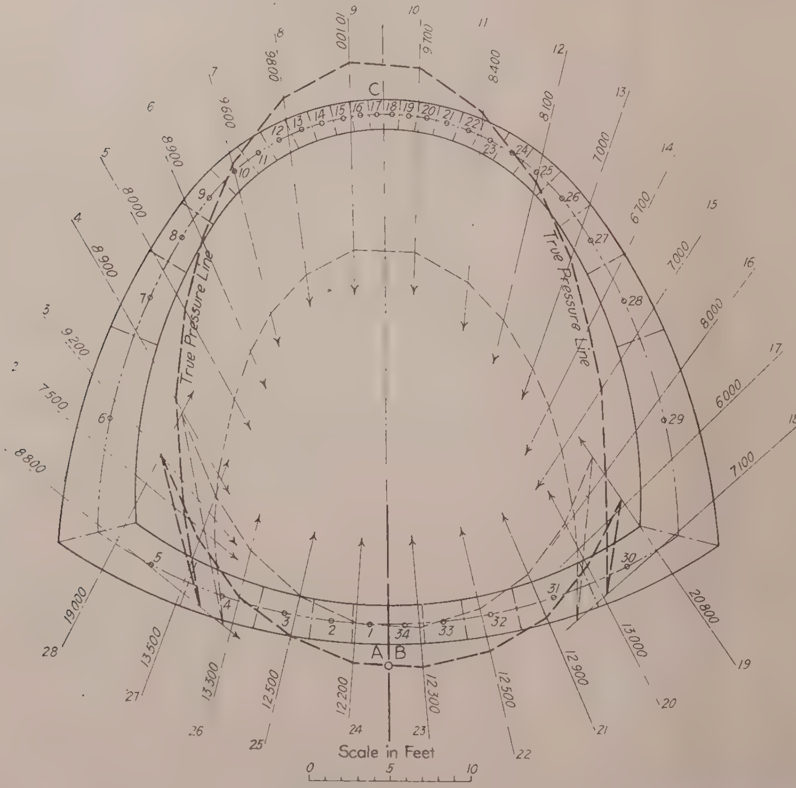
THEORY OF VIRTUAL DISPLACEMENTS

Imagining the invert cut at the center and considering the conduit as a curved cantilever fixed at B, the theory of virtual displacement requires that the total changes in relative deflections and angle shall be zero, and the equations 1 were derived in the preceding article to satisfy this condition. The values of H, V and M are in this case the thrust, shear and moment at the center of the invert.

The values of x and y are measured algebraically from the vertical and horizontal axes passed through the "center of gravity" of the divisions of the arch ring. In locating this "center of gravity," the divisions are all given equal weight because the values of $\Delta s/EI$ are all made the same. The summation of the values

$$\sum_A^B M_1 x,\ \sum_A^B M_1 y,\ \sum_A^B x^2 \text{ and } \sum_A^B y^2$$

proceed around the arch from the free end,



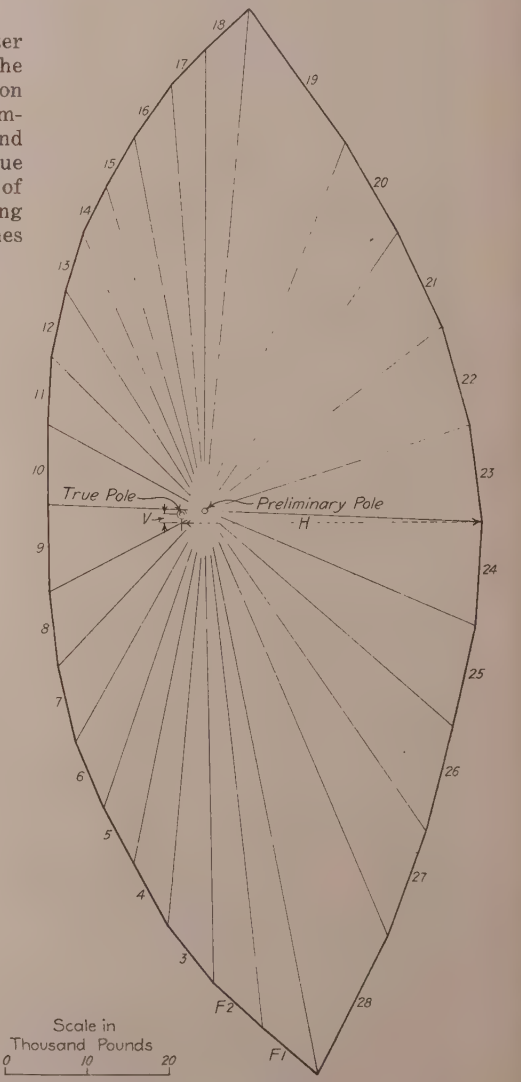


FIG. 3—LOADING ON CONDUIT—TRIAL AND TRUE PRESSURE LINES CONSTRUCTED BY FORCE POLYGONS

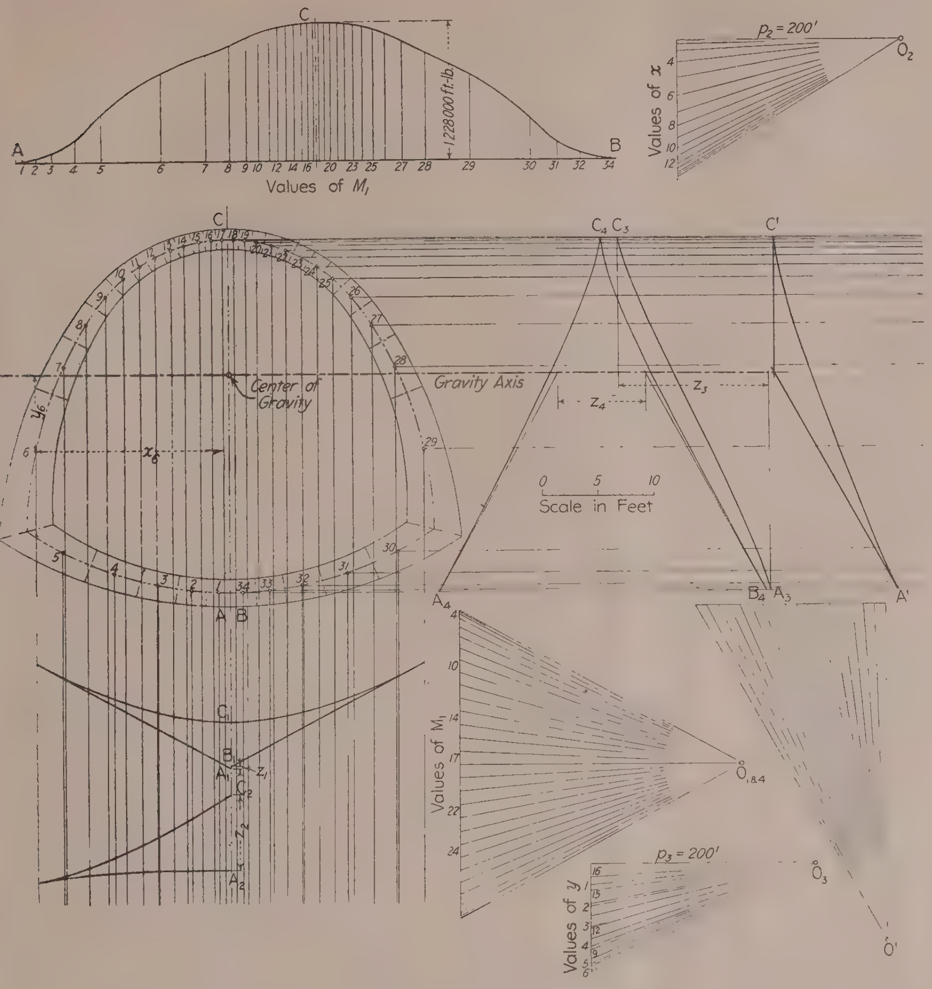


FIG. 4—GRAPHICAL DETERMINATION OF VARIOUS SUMMATIONS

and their values may be obtained easily and accurately by the graphical method explained in Church's "Mechanics of Engineering" or other texts on graphics. The summation is effected by means of funicular polygons.

APPLICATION OF THEORY—GRAPHICAL SOLUTION

All of the graphical work involved in the location of the true pressure line of the conduit for the assumed condition of loading is given in Figs. 3 and 4. In order that a check might be had, the same condition of loading was assumed as used by Mr. Smith and the results agreed very closely with his except in the case of the shear, which he did not investigate, because the load of the conduit is nearly symmetrical.

The procedure is as follows: The conduit is first laid out and divided up as in Fig. 3, so that the values of $\Delta s/EI$ are all the same. The lines of action of the forces acting on the conduit are then drawn in and the force polygon is constructed. The invert is assumed cut by a vertical section at the center; the end B is considered fixed and A free. Since the end A is free the bending moment there must be zero, and the equilibrium polygon is therefore started at the neutral axis at the section cut. Any convenient position of the pole may be selected, as the first equilibrium polygon is used only to determine the moments in the bent cantilever due to the earth pressure. By means of the force and equilibrium polygons, the moments M_1 at the center point of each of the divisions of the arch are computed, and the resulting curve of moments is given at the top of Fig. 4.

The arch rib is again laid out for use in determining *H*, *V* and *M*, and the center points of the divisions are projected in parallel lines to the right and downward for the construction of the funicular polygons, Fig. 4. In order to locate the gravity axis, the rib divisions are treated as equal forces acting horizontally and their resultant is located by the ordinary graphical method. The force polygon with pole at O' and the funicular polygon A'B' were used for this purpose. When this axis is located the values of *y* may be measured from it. The values of *x* are measured from the vertical axis through the center-of-gravity point.

DETERMINATION OF THRUST

The two summations $\sum_A^B M_1 y$ and $\sum_A^B y^2$ are obtained from the two funicular polygons A_4B_4 and A_3C_3. The values of M_1 from the M_1 curve are laid off on the load line of a force polygon, and a convenient pole is chosen ($O_{1\ and\ 4}$). The funicular polygon A_4B_4 is drawn with its sides perpendicular to the rays of this force polygon. The value of $\sum_A^B M_1 y$ is equal to the length z_4 multiplied by the pole distance $p_{1\ and\ 4}$ of the force polygon. In the same way $\sum_A^B y^2$ is obtained. The values of *y* are laid off algebraically on the load line of the force polygon whose pole is at O_3. The funicular polygon A_3C_3 is constructed with sides perpendicular to the corresponding rays. Since the arch is symmetrical, only one-half of the funicular polygon need be drawn. The value of $\sum_A^B y^2$ is then $2z_3p_3$, and

$$H = \frac{\sum_A^B M_1 y}{\sum_A^B y^2} = \frac{z_4 p_{1\ and\ 4}}{2z_3 p_3}$$

If found convenient, the pole distances can be made equal and will then cancel out. The numerical value of *z* is, of course, measured to the same scale as the arch, and that of *p* to the scale of the load line.

DETERMINATION OF SHEAR

The vertical shear at the center of the invert is found in the same manner as *H*. The value of $\sum_A^B M_1 x$ is taken from the funicular polygon A_1B_1 drawn with sides parallel to the rays of the M_1 force polygon (pole at $O_{1\ and\ 4}$) and is equal to *z* times p_1. The value of $\sum_A^B x^2$ is taken from the funicular polygon A_2C_2 drawn with sides parallel to the *x* force polygon with its pole O_2.

Only half of the funicular polygon is drawn, because of symmetry, and

$$\sum_A^B x^2 = 2z_2p_2$$

Therefore

$$V = \frac{\sum_A^B M_1 x}{\sum_A^B x^2} = \frac{z_1 p_1}{2z_2 p_2}$$

Because of the symmetry of loading the shear *V* is quite small in this case.

DETERMINATION OF MOMENT

The moment *M'* is equal to $\left(\sum_A^B M_1\right)/n$, in which *n* is the number of divisions of the arch ring (thirty-four in this case). The term $\sum_A^B M_1$ can be measured directly from the M_1 load line. The true moment *M* is equal to $M' + Hb - Vl/2$, which reduces to $M' - Hb$ in this case, because *l*, the distance between the ends of the arch, is zero, and *H* is negative.

The numerical results obtained at the center of the invert of this conduit are as follows:

Thrust:

$$\sum_A^B M_1 y = 7.90 \times 25{,}000{,}000 = 197{,}500{,}000$$
$$\sum_A^B y^2 = 2 \times 13.28 \times 200 = 5310$$
$$H = 197{,}500{,}000/5310 = 36{,}800 \text{ lb.}$$

Shear:

$$\sum_A^B M_1 x = 0.12 \times 25{,}000{,}000 = 3{,}000{,}000$$
$$\sum_A^B x^2 = 6.75 \times 2 \times 200 = 2695$$
$$V = 3{,}000{,}000/2695 = 1100 \text{ lb.}$$

Moment:

$$\sum_A^B M_1 = 27{,}400{,}000$$
$$n = 34$$
$$M' = 27{,}400{,}000/34 = 806{,}000 \text{ ft.-lb.}$$

The distance from the center of gravity

to the pressure line at the center of the invert is

$$M'/H = 806{,}000/36{,}840 = 21.87 \text{ ft.}$$

which brings the pressure line 2.5 ft. below the neutral axis.

Knowing the values of H and V and the location of the true pressure line below the center of the invert, the true pole can be located and the true pressure line drawn in. The value of V in this case was not determined very accurately, because of the small scale used, but it is small and relatively unimportant. The thrust and position of center of pressure check those obtained by Mr. Smith within 2 per cent.

EFFECT OF RIB SHORTENING AND TEMPERATURE

The effect of change of temperature on the conduit is to increase or decrease the size of all parts in the same proportion; and, if the conduit were not surrounded by material which resisted the expansion, no stresses would be produced by temperature change. The effect of expansion must be to increase somewhat the pressure of the surrounding earth, but to what degree it would be impossible to estimate, and the writer is at a loss to see how the temperature stresses can even be approximated. The entire rib is under a heavy thrust and the effect of rib shortening would therefore be small.

The consideration of temperature and rib-shortening stresses in a conduit in an earth fill would seem to be a useless refinement when the external forces are of such an indeterminate nature. A conduit subjected to hydrostatic pressure would present a very nice problem, but the pressures in an earth fill are an entirely different matter. No experiments have revealed any accurate law by which the pressures in a deep fill, affected so much by arch action and varying conditions, can be figured. It would therefore seem sufficient to estimate the pressure as carefully as possible, as Mr. Smith has apparently done, and to determine the true pressure line without any undue refinements.

In spite of the simplicity of the graphical application of the theory of virtual displacements which has been explained, the writer has not been able to find a single record in English of its use in solving such a problem as that presented by the reinforced-concrete conduit. This may possibly be attributable to the tendency of American engineers toward analytical methods which involve no drafting, and many may receive the impression from the appearance of Fig. 4 that too much graphical work is involved for accurate results. This is not true, because there are easy checks and less possibility of gross error, and the results can easily be brought within the common standards of accuracy. The basic assumptions made in the application of the general theory of elasticity to such structures are themselves productive of much greater error than any reasonable error which could be made in the graphical constructions.

NATIONAL FORESTS RECEIPTS, during the year ending June 30, amounted to almost $2,500,000, an increase of more than $40,000 over the preceding year. Timber sales amounted to $1,164,000, a decrease of about $79,000 from the amount received during the last year, but the water power receipts and the grazing receipts showed increases of about $42,000 and $127,000 respectively.

Recent Legislation for Water Conservation Reviewed and Criticised

Morris Knowles Makes Comparison of Various State Laws and Gives the Principles of Wise Legislative Enactment

SUGGESTING the fundamental principles for the type of conservancy legislation most to be desired, Morris Knowles, member of the Pittsburgh Flood Commission, presented before the recent National Drainage Congress a paper entitled "Wise Water Conservation Legislation," which contains a comparison and critical review of the recent legislation in various States. The following extracts contain his more important statements and conclusions:

Never before in the history of our country has there been so much attention directed to legislation on matters connected with flood prevention, water conservation and stream regulation as during the past two or three years. The great overflow in the Mississippi Valley in 1912 and the widespread damage by the great storm of 1913 appeared to have been effective in arousing the public to the need of governmental action on these subjects. A compilation of the bills that have been under consideration and the acts that have been passed in the various State and National legislatures during the past three or four years would be extremely interesting and helpful. A few instances typical of various forms of legislation that have been adopted will be referred to as examples.

PENNSYLVANIA CONTROL OF WATER

In 1913, under the influence of the public agitation subsequent to the flood of that year, the Pennsylvania Legislature enlarged the powers of the Pennsylvania Water Supply Commission, established about ten years ago, by giving it more extensive authority with respect to the construction and maintenance of dams and the power to require correction of defects in existing structures, and authorized a complete inventory of the water resources of the State, a study of the flood problem, consideration of possible locations of dams for stream regulation and water conservation, and the study of a public policy for the equitable distribution and marketing of public waters.

In the State of New York a conservation commission of three members was established several years ago, and by successive amendment and additions to the conservation law this commission has acquired unusually extensive powers in connection with hydroelectric development, stream regulation, supply of water and drainage. The act was amended in several important particulars during 1913, and in 1915 important amendments were adopted relative to the regulation of streams by storage reservoirs and reducing the number of commissioners to one.

POWERS OF NEW YORK COMMISSION

The powers of this commission include the right of entrance, the right of eminent domain, and authority to construct projects, provide money by bond issue and assess the costs by taxation in proportion to benefits. The commission may originate projects for hydroelectric development and may undertake stream regulation and drainage projects for which petition is made in accordance with the law. It is also given complete supervision over storage-reservoir projects undertaken by local districts organized under the 1915 amendment.

The unusual feature of the act, apart from the broad powers of the commission, is the small measure of power left with the inhabitants and local officials of the community affected, except in the case of storage projects under the 1915 amendment. When improvement of a stream by other means than reservoirs or drainage improvements are petitioned for by any county, city, town or village, it rests entirely with the commission whether or not public health and safety warrant the undertaking of the projects by the State, and thereafter the commission has entire control of the planning, financing and construction of the project and the distribution of the cost.

The 1915 amendment changes these provisions as to projects for river regulation by storage reservoirs, and in this branch of the subject is the best piece of such legislation with which the author is acquainted. It provides for the organization of river-improvement districts, with resident freeholders as directors, and endows the board of directors with all of the powers granted to the conservation commission in connection with other work under the act. Avoidance of conflict and a consistent State policy are assured, however, by requiring the approval of the commission at every step. The only criticism of this part of the act is its restricted application.

OHIO CONSERVANCY LAW

The Ohio conservancy law, which has attracted so much attention, attacks the proposition from an entirely different standpoint. A given number of property holders may petition for the organization of a conservancy district and the courts of common pleas of the counties affected must determine upon hearing whether or not the organization of the proposed district is in the public interest.

When such a district is organized its directors are endowed with powers almost as far-reaching as those of the New York Conservation Commission. The plan of their project is subject to the approval, after hearing, of the courts of common pleas, which may also hear protests against the assessment of benefits by the board of appraisers appointed by the court upon recommendation of the district directors. The districts are given the right of eminent domain, authority to issue bonds and construct and operate conservancy projects, and the right to levy assessments in proportion to benefits upon the property within the district.

INDIANA LEGISLATION OF 1915

The Indiana legislation, which resulted in 1915 from the floods of the preceding years, is a mingling of adaptations of the Ohio act. Five bills were passed by the 1915 Legislature, authorizing the organization of various kinds of flood-prevention and drainage districts and allotting various degrees of authority to the district directors and the circuit courts of the counties involved. Three of the acts were passed for the benefit of the cities of Fort Wayne, Indianapolis and Peru, respectively, and practically authorized these cities to carry out flood-prevention work, leaving the planning entirely within their power, and to assess a portion of the cost upon all or part of the counties in which they are situated.

A drainage-district act was adopted permitting the organization of drainage districts by circuit courts upon the petition of a majority of the property owners or resident owners of a majority of the acreage lying within the proposed district. A general act was passed covering flood prevention in cities of the second, third, fourth and fifth classes, and incorporated towns.

COMPREHENSIVE POLICY NEEDED

The Pennsylvania law lays proper stress upon the needs of thorough investigation and upon the formulation of a comprehensive State policy with respect to the conservation and utilization of its water resources; it is defective, however, in that it hinders private development by depriving it of the right of eminent domain, and in that it provides no means by which local, public and private interests can be organized with suitable powers for conservancy work. By the failure to provide appropriations in 1915, it has made impossible a continuous program to complete investigations, and therefore does not assure a comprehensive State policy at a time when stream regulation is sorely needed in order to prevent repetition of flood disasters and also to provide for the utilization of the one inexhaustible power resource which this great mineral State possesses.

The New York law assures harmonious policy by placing the control of private projects, as well as the inception and execution of public conservancy projects, in the hands of a single State commission and endows that commission with ample powers of the most far-reaching kind. And as to storage-reservoir projects, with the exception of certain minor details, it approximates closely to the legislation which the author considers ideal.

The Ohio law endows local authorities with powers almost as comprehensive as those of the New York commission with relation to the inception, financing and construction of projects. It fails, however, to provide the assurance of harmony and consistent policy provided by the Pennsylvania principle of commission approval of private projects and the New York principle of complete central control, and substitutes therefor an unsatisfactory scheme by which the already overloaded courts are given the burden of deciding upon issues raised at hearings by the various interested parties.

TYPES OF CONSERVANCY LEGISLATION THAT ARE MOST DESIRABLE

Enough has been said to suggest the principles which seem most important as a foundation for the type of conservancy legislation which is most to be desired and which is as yet without representation on the statute books of America. Such legislation should make ample provisions for the study of the problems of conservancy and river regulation and the formulation of a comprehensive policy which will treat each stream as a unit from its source to its mouth, and take into account all the possible uses of water; it should encourage private initiative by granting, under State and Governmental control, the right of eminent domain and other appropriate powers, and it should give scope to civic enterprise by providing for the organization of conservancy projects under the direction of local authorities with powers of the most far-reaching kind.

Finally, all wise legislation should assure the correlation of various projects within the same drainage basin and the harmony of all such projects with public policy and a comprehensive public program for the utilization of water resources by the establishment of State and National commissions with adequate supervisory powers and full authority to control local districts to this end.

Letters to the Editor

Comment on matters of interest to engineers and contractors will be welcomed

Longest Tunnel in America

Sir: I note on page 264 of the Engineering Record of Aug. 28 that the Rogers Pass tunnel, having a length of 26,400 ft., is reported to be the longest tunnel in America.

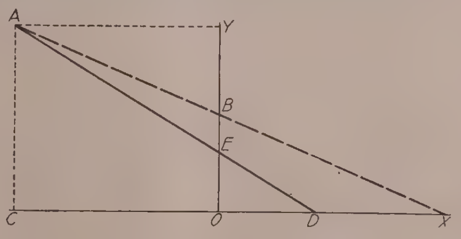
I am forwarding under another cover a marked copy of the Thirteenth Annual Report, page 406, giving a table of tunnels, built, under construction and proposed by the Reclamation Service. You will note that the Gunnison tunnel, already constructed, is 30,645 ft. in length.

MORRIS BIEN,
Acting Director, U. S. Reclamation Service.
Washington, D. C.

[Attention is also called to the 18-mile city aqueduct tunnel for the new Catskill water supply for New York City. Ordinarily, however, when tunnels are mentioned one thinks of railroad tunnels, and the Rogers Pass bore is believed to be the longest railroad tunnel in America.—EDITOR.]

To Construct Nomographic Charts for Kutter's Formula

SIR:—I have read with great interest in your issue of June 26, page 809, the article on the use of nomographic charts, and it has occurred to me that it may be news to many of your readers who are interested in sewerage that similar diagrams may be constructed for the solution of Kutter's formula of discharge.



The diagram is illustrated in the figure herewith, and is used to obtain the value of the constant c in the formula $v = c\sqrt{RS}$, where v is the velocity in feet per second; R the hydraulic mean depth, and S the sine of the angle of slope. In this equation

$$c = \frac{l/n + (a + m/S)}{(a + m/S)n/\sqrt{R} + 1}$$

where a, l and m are experimental constants determined by Kutter as 41.66, 1.811 and 0.00281 respectively, in English measure. Of course n is the so-called "coefficient of roughness."

In the figure OY and OX represent the ordinary axes of rectangular co-ordinates. Mark off OD to any chosen scale to represent l, and OE to represent l/n. Then

$$\tan \angle \mathrm{OED} = \mathrm{OD}/\mathrm{OE} = n$$

Mark off EY to represent $a + m/s$ to the same scale that OE represents l/n. Then OY represents $l/n + (a + m/S)$. Draw YA parallel to the axis of X to cut DE produced in A, and draw AC parallel to the axis of Y. Then

$$\angle \mathrm{AEY} = \angle \mathrm{DEO} = \tan^{-1} n$$

and

$$\mathrm{CO} = \mathrm{AY} = \mathrm{YE} \tan \angle \mathrm{AEY} = (a + m/S)n$$

Mark off OX to represent $\sqrt{R}$. Then

$$\mathrm{CX} = (a + m/S)n + \sqrt{R}$$

Join AX, cutting OY at B. By similar triangles

$$\frac{\mathrm{OB}}{\mathrm{OX}} = \frac{\mathrm{AC}}{\mathrm{CX}} = \frac{\mathrm{OY}}{\mathrm{CX}} = \frac{l/n + (a + m/S)}{(a + m/S)n + \sqrt{R}}$$

Therefore

$$\frac{\mathrm{OB}}{\sqrt{R}} = \frac{l/n + (a + m/S)}{(a + m/S)n + \sqrt{R}}$$

$$\mathrm{OB} = \frac{l/n + (a + m/S)}{(a + m/S)n\sqrt{R} + 1}$$

This is the value of c. In preparing the diagram care must be taken with the scales. Those along the axis of X are to the scale of l. Those along Y may be to any other convenient scale.

Tables of the various values of $a + m/S$, l/n and $\sqrt{R}$ are given in Moore's "Sanitary Engineering."

G. S. COLEMAN.
Manchester, England.

Longleaf Pine Specification Should Include Density Test

SIR:—I want to thank you for the commendation of the work of this laboratory in your editorial "Visual Identification of Longleaf Pine—Its Importance," in the Engineering Record of Sept. 18, page 342.

It appears desirable to make further comments on the relation of identification of longleaf pine to the density classification of the Southern pine used in the grading rules. For a great many years the term "longleaf pine" has been used to designate the best quality of the Southern pines, and whenever a shipment of timber did not come up to expectations it at once was classed as not true longleaf, the idea being that all true longleaf was of good quality when free from defects, and that commercial longleaf admitted all true longleaf (*Pinus palustris*), and the best timbers of the Southern pine.

The above view of the subject is not altogether correct. True longleaf pine averages stronger and better than most of the other Southern pines and will, undoubtedly, furnish most of the timbers of the new select structural grade of the Southern Pine Association. Tests on pieces clear from defects have shown, however, that a small per cent of the longleaf pine is to be classed with the poorer grades of shortleaf and loblolly for strength, and some of the loblolly and shortleaf is to be classed with the better grades of longleaf. Some pieces of true longleaf are so lacking in density (and this is generally true of other species) that were we to waive the density requirement a timber having maximum defects allowed in the select structural grade would have only about two-thirds of the strength of the poorest timber that should be admitted, and only about 45 per cent of that of the average timber of the grade. Furthermore, it would be expected to fail in less than a year with a dead load producing a stress of 1600 lb. per square inch.

The point that I have endeavored to make is that the density classification is necessary even though one is able to distinguish the species, and the fact that one has true longleaf-pine structural timbers comparatively free from defects does not offer an absolute guaranty of the strength and durability of those timber; but by using the pith-identification method with the density requirements, one is sure of getting not only true longleaf pine but a very good grade of this timber.

HOWARD F. WEISS,
Director, Forest Products Laboratory.
Madison, Wis.

If Decimals of Degree Why Not Decimals of Full Circle?

SIR: The new railroad engineers' field manual by Prof. William G. Raymond, of the State University of Iowa, in which the author attempts to introduce the decimal division of the degree in lieu of the sexagesimal, is deserving of the greatest success. Whether the apparent antagonism of the engineering profession toward radical changes of this nature will allow it to have such success is problematical. Numerous and varied criticisms and objections have been, and doubtless will be, made to the proposed change.

The writer has but one criticism to make, and that is that Professor Raymond did not go far enough. If, as the author asserts, the decimal division of the degree is an advantage, why would not the decimal division of the circle be an added advantage? If not desirable to divide the quadcircle decimally, why not divide the quadrant, as the writer has seen done in certain European instruments? As Professor Raymond proposes, the degree has 100 divisions while the quadrant still has 90 and the circle 360, just as there are still 12 in. in a foot and 3 ft. in a yard. The writer would favor dividing the circle into 100 divisions. This would be no more radical than merely dividing the degree; no more so than using tenths of a foot instead of twelfths. A degree, or whatever it might be called, would be much larger than the present degree, but the size of the unit is of no consequence if its divisions are made small enough. In the decimal system, naturally, there is no limit to divisibility. It certainly would make no difference, so far as accuracy is concerned, whether we call a certain angle 22 deg. 30 min. or 6.250 deg., both of which would represent one-sixteenth of a circle. With the decimal system throughout we could have an angle designated by any number of decimal places, whereas in the present system if we divide beyond seconds our only recourse is decimals. Why not do it all by decimals?

As Professor Raymond says, there are almost no solutions of curve problems in which it is not necessary at some time to translate degrees, minutes and seconds to decimals of a degree and vice versa. In a lesser measure this is true of all surveying work. But even if it were not true, the change proposed would be justified by the saving in time and the eliminating of the chances of error in the simple processes of addition, subtraction, multiplication and division. And it would certainly be much simpler to find the angle between 12.243 deg. and 43.675 deg. than it is between N 44 deg. 4 min. 29 sec. E and S 22 deg. 46 min. 12 sec. E—the former representing the same angle by the full decimal system that the latter does by the antiquated system surviving from the days of the archaic compass and Jacob's staff. Compare the multiplication of 0.5723 by 1.234 deg. with the multiplication of 0.5723 by 4 deg. 26 min. 33 sec.

The superiority of the decimal system as advocated by Professor Raymond is so pronounced that it is sincerely hoped by the writer that it will be generally accepted by the profession. It is also hoped that the professor will continue his labors along the lines suggested herein, giving us full tables based on the decimal division of the entire circle with the necessary new unit names.

In view of the many ill-fated attempts to introduce the metric system into the United States, the writer is inclined to take the pessimistic view that Professor Raymond's efforts are doomed to failure. It is clearly time, however, that the profession ceases its poring over handbooks to find how many gills there are in a pint, or how many cubic feet in a perch. The time and energy wasted in finding one-fifth of 1 ft. 7¾ in., or six times 4 lb. 5½ oz., is enormous, and the efforts made in dividing 67 deg. 46 min. 37 sec. by 14 can just as well be spent at some more profitable task.

R. C. HARDMAN.
Colorado Springs, Col.

Lettering Land Sections for Federal Valuation Maps

SIR: In the Engineering Record of June 26, page 814, I noticed a letter from L. W. Duffee in regard to lettering land sections for maps to be used in connection with the Federal valuation work. I would like to make a few criticisms of some of Mr. Duffee's conjectures, which I do not believe apply to modern railway drafting. In my experience, which covers about fourteen years with a number of the leading railroads of the country, I have found only in a very few instances where railroad engineers follow the system suggested by Mr. Duffee, that is, lettering upside down on tracings.

The map order of the Interstate Commerce Commission requires all maps to have a north point on them not less than 5 in. in length, and on all maps where the land has been sectionized the order requires that the number of all sections be shown according to the American Railway Engineering Association's standard specifications, that is, with the section number in the center of the section with township and range. It would seem to me that it would cause a lot of confusion and be a waste of a lot of valuable time to letter the maps so as to indicate north by such.

We have here on our line something more than 1200 miles of alignment maps on a scale of 400 ft. to 1 in. and hundreds of station maps on a scale of 100 ft. to 1 in. to make, and it would cost this road at least 1 per cent more to indicate north by the lettering shown on the tracings.

Mr. Duffee refers to the Government township plats as an example. I would like to state that all of these plats are made in standard-sized sheets with the top of the sheet indicating north, and it is much better to letter the plats so as to indicate north; also, it is not necessary to put the north point on a map or plat of this kind, and it is never done.

L. M. MACARTHUR,
Chief Draftsman, Engineering Department of Valuation, Mobile & Ohio Railroad.
Mobile, Ala.

Odor Nuisance Abated Following Court Trial

SIR: The criminal suit of the Commonwealth of Pennsylvania vs. Grays Ferry Abattoir Company was tried at Philadelphia, Sept. 27-29. The Commonwealth charged the abattoir company with maintaining a nuisance due to objectionable odors originating at its plant, located at Grays Ferry Road and the Schuylkill.

A large number of witnesses were summoned by both sides and there was much testimony given to show that odors, variously described as that of burning flesh or heated animal matter, had been traced to the plant of the abattoir company.

On the third day of the trial Judge Bregy called a recess, and a conference was held between lawyers on both sides, representatives of the abattoir company and experts called by the Commonwealth, including Dr. Joseph Shears, sanitary expert, Board of Health, New York City, and the writer. The company then agreed to make whatever correction was necessary at its plant to comply fully with the regulations governing bone-boiling establishments and depositories of dead animals. This included means of controlling objectionable odors by providing a tight building and mechanical equipment for the treatment of the odors and for supplying ventilation. An agreement was drawn up stipulating that plans and specifications would be submitted in three weeks and the work completed 60 days from date of conference.

Upon the reopening of Court the abattoir company pleaded nolo contendere. This plea was approved by the Court and the jury dismissed.

This case is important in that a successful attempt was made to relieve residents in the vicinity of West Philadelphia and the east side of the Schuylkill River from a very annoying nuisance. The outcome of the suit will doubtless lead to further actions looking toward the control of objectionable odors from industrial plants in the city.

GEORGE H. SHAW,
Sanitary Engineer, Bureau of Animal Industry, U. S. Department of Agriculture.
Washington, D. C.

CEMENT to a total of 87,257,552 bbl. was produced in this country in 1914, according to the U. S. Geological Survey.

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

[*Contributions to this section are solicited, and if found available will be paid for. They must be* SHORT, *and should be accompanied, if possible, by photographs or sketches.*—EDITOR.]

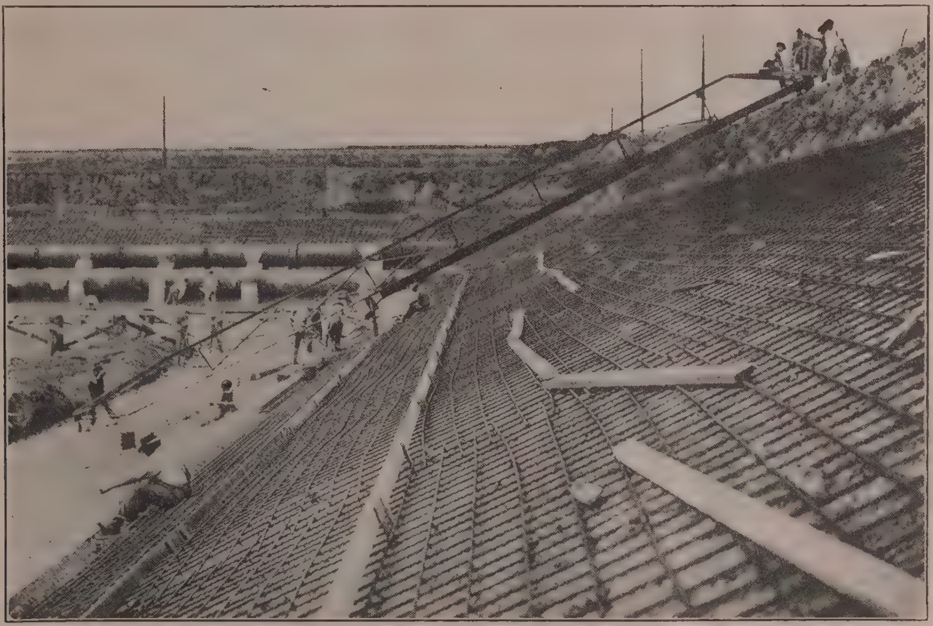
Trussed-Steel Chute Places Concrete Economically on Slope

By HOMER V. KNOUSE

Construction Engineer, Metropolitan Water District of Omaha

THE INCLINED steel truss, rolling on wheels at the top and bottom, shown in the accompanying photograph, carries steel chutes made in 2-ft. removable sections, and has proved very economical in concreting in 5-ft. horizontal strips the sides of a reservoir basin at Omaha.

In constructing an earlier basin, No. 3 of the Walnut Hill reservoir, during the summer of 1914, it was found that 5 ft. was the maximum width for horizontal courses on the slope if concrete of the proper consistency to incase reinforcing was to be placed without sliding. It was thought advisable to pour a complete course each day to reduce the joints to a minimum, and as the average length of a course is about 1000 ft., frequent and rapid moving of the chutes was necessary. A wooden chute of semi-flexible construction in 5-ft. lengths was used on the first basin, but was replaced with considerable saving by the steel-trussed chute shown, on the next basin built, which is an addition to the Florence Station of the water district.



ROLLING CHUTE GIVES WIDE DISTRIBUTING RANGE AT SMALL EXPENSE

The steel truss supports the chute from its lower chord, and is mounted on wheels at each end which are attached through trunions or castors to permit greater latitude of movement when passing around the curves at the corners of the basin. The chute is built in 2-ft. lengths without circumferential riveting, which permits the removal of sections in a few minutes' time when a course is completed, or when it is necessary to change the point of discharge. The upper section of chute is flared so that a 6-cu. ft. concrete car can dump its load directly into the chute.

Two 36-in. supply pipes which cross the north end of the basin made it necessary to raise the lower end of the chute while pouring this side, and the elevated runway shown at the left in the illustration was provided for this purpose. The lower end of the truss is raised to this platform by a light derrick. The weight to be raised each time was about 1 ton, as the chute and truss when empty weigh about 4000 lb.

With this arrangement a considerable reduction in the number of men necessary to handle the concrete was possible. Not only is the chute easier to handle, but the point of discharge may be regulated closely, so that little spreading of concrete inside the form is necessary. Further work of a similar nature is contemplated by the Metropolitan Water District of Omaha, which built the basins described, and it will be possible to modify the chute for this work at slight additional expense.

Dry, Coarse Sand Best for Cement Gun in Wet Climate

CLOGGING, due to large sand particles, wet sand, and wet air, was the principal trouble encountered by Maj. W. G. Caples, Corps of Engineers, U. S. Army, in using the cement gun to build concrete revetments for the protection of levees on the lower Mississippi River. It was also proved on this work, described by Major Caples in a paper on page 650 of the *Professional Memoirs* for September-October, 1915, that a 4-in. layer of concrete could be made in place on the levees by first spreading gravel to that thickness and then applying gunite. This penetration, however, could only be obtained at reasonable expense with the gravel from a certain pit, which passed a 2-in. screen and was all retained on a ¾-in. screen. For other locations a revetment 2 in. thick of plain gunite was used.

Wet sand forms lumps with the cement before it reaches the gun, and causes the cement to set in the gun, destroys the gaskets, clogs the feed wheel and causes a great deal of trouble. As the extent of the work made heating the sand expensive, it was stored in small conical piles where it could drain easily. The dry sand and cement were mixed and passed through a ½-in. screen before being fed to the cement gun.

Wet air and foggy weather caused the cement to set in the passages of the gun and made their cleaning difficult. This condition was helped by using coarse sand, having many particles just passing the ½-in. screen, which scoured out the gun and kept the cement coating from accumulating in the passages.

Home-Made Machine Cleans Cement Bags at Big Saving

A MACHINE for cleaning cement sacks, which cost $900 to make, displaced three men and effected an annual saving of $2172 for the maintenance-of-way department of the Cleveland Railway Company, Cleveland. The machine is composed of four essential parts: motor, drum, exhaust fan and dust collector. The motor drives the exhaust fan and the cleaning drum through a set of reduction gears. The octagonal drum is 5 ft. wide and 12 ft. in diameter and is constructed with wooden sides with a ½-in. mesh screen on the periphery. It is mounted on a shaft in a room, which is as near air-tight as possible. The motor revolves the drum at the rate of about 10 r.p.m. At one of the upper corners of this room, which is practically filled by the drum, an air intake is installed. At the diagonally opposite corner on the floor an outlet leads through the exhaust fan to the dust collector. As the drum revolves the exhaust fan draws the air through the drum, removing the cement dust, which is deposited on the floor of the room. Only a small amount of cement is drawn out of the room and deposited in the dust collector. One thousand sacks are placed in the drum at one time and revolved for 30 min. A period of 5 min. is allowed for the dust to settle before the sacks are removed.

Heretofore the company found it necessary to detail three men to clean cement sacks. These men beat the sacks against a post, but they made no attempt to save any considerable quantity of the cement. They each received 20 cents per hour and they cleaned approximately 1000 sacks a day. As an average of 250,000 sacks of cement were used per year, considerable time was consumed by the men in cleaning sacks. It was found that 1000 empty cement sacks weighed 1313 lb., but after being machine cleaned they were reduced in weight by 707 lb. The freight rate on sacks returned from Cleveland to the cement mill was 8 cents per hundred, hence a saving of 56 cents per 1000 sacks in the freight charges was obtained. This represented a total annual saving in freight alone of $120. In addition the 707-lb. reduction in weight represented cement salvaged from the empty bags. In other words, 442 bbl. of cement represented the annual saving from 250,000 sacks. At $1.25 per barrel, this meant an annual saving of $552.52. Besides these two items, the three men employed in cleaning the sacks were eliminated, hence another saving of $6 per 1000 sacks was made, or $1500 a year. Thus the cement-sack-cleaning machine saved $2172 a year, or more than twice the original cost of the machine.

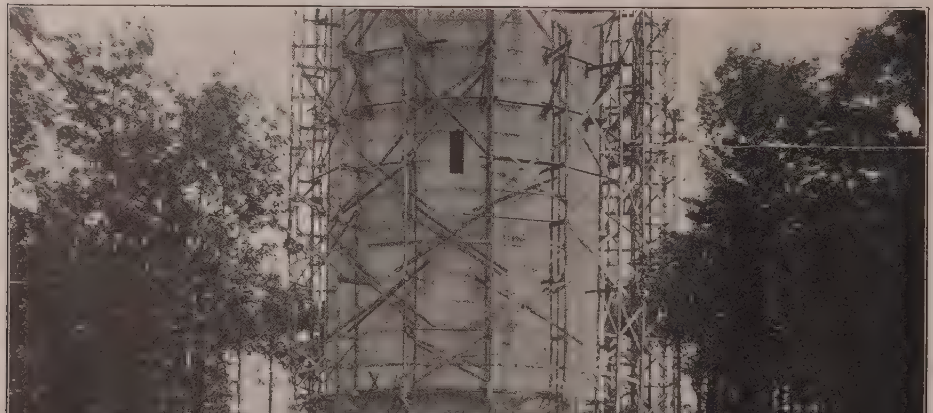
An adjoining storage room was equipped with a special sewing machine for mending torn bags. During the winter months one of the men in the concrete gang who had become an expert at patching bags mends between 200 and 250 sacks a day for which he receives $2. A cement-sack-bundling machine also forms part of the equipment of this storage room. Charles H. Clark, engineer maintenance of way, invented the bag cleaner.

Cableway Carries Curved Reinforcing Bars Up Steep Hill

By GEORGE W. DAVIDSON
General Foreman, Hennebique Construction Company, Middleboro, Mass.

THE LIGHT cableway shown in the accompanying illustration was used to advantage in transporting up a steep hill 48-ft. curved reinforcing bars used in the construction of a large reinforced-concrete water tower. The bars were 1¼ in. diameter bent to a radius of 21 ft., half the diameter of the water tower. Teams could not negotiate the hill, and because of the shape and size of the bars they could not be loaded on any small vehicle. It took six men to carry one of the bars up the hill. To overcome this difficulty, a ⅝-in. cable was drawn taut over shear-legs on the line of travel from the base of the hill to the bottom of the tower. On this was mounted a single-wheel trolley from which a short tackle was suspended. With this rig two rods at a time are raised clear of the ground and quickly pulled up hill. The cableway is operated by three men.

This water tower, which is 173 ft. high, is being built by the Hennebique Construction Company, for whom the writer is general foreman.



WITH THIS RIG 3 MEN HANDLED 12-MAN LOADS UP HILL TOO STEEP FOR TEAMS

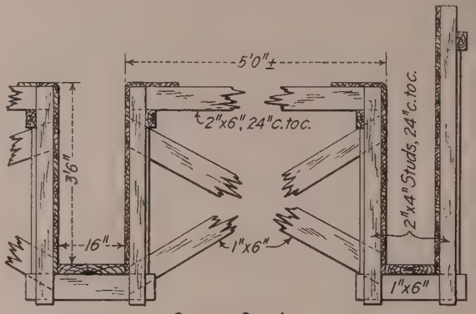
Forms Built Before Supporting Falsework for Concrete Bridge

By R. C. HARDMAN
Colorado Springs, Col.

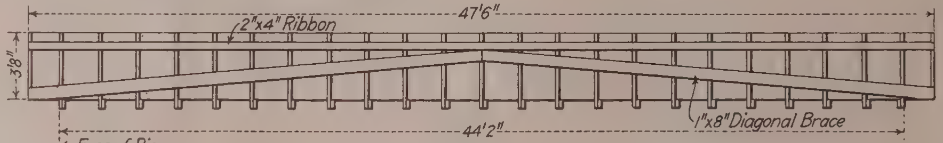
IN THE construction of a bridge superstructure consisting of long-span girders of reinforced-concrete, it was not desirable to erect the supporting falsework in advance of the girder and slab forms. A form design was worked out which would permit of the entire deck form being temporarily self-supporting. After this was erected, it was used to raise the falsework to support itself till the concrete had set.

The spans were of various lengths, the longest being 44 ft. 2 in. clear span and 31 ft. above the ground. The largest girder was of this length with a section of 16 x 42 in., the form being 47 ft. 6 in. long with a bearing of 20 in. on each pier. The type of form is shown in the accompanying sketch. The form sides, consisting of 2 x 4-in. verticals spaced on 24-in. centers, and 1 x 6-in. lagging, were built flat upon the ground in pairs. On the outside face of each was spiked a 2 x 4-in. ribbon to receive the floor joists according to customary practice. In addition, however, there were placed two diagonal braces of 1 x 8-in. plank running from near the middle of the top to the ends of the bottom of the form. These were securely spiked to each stud so that they would be able to resist either compression or tension.

In erecting, a pair of sides were placed between piers approximately under their location above, their bottoms fastened by means of 1 x 6-in. cleats as shown, the 2-in. girder bottom placed and temporary cleats nailed across the form at the top as spacers, so that the form for the girder was complete on the ground. A portable ginpole having a hand windlass at its bottom was used for hoisting the form into place. This was done by a line around the middle of the girder form, which placed the diagonals in tension. As the over-all length of the form was greater than the clear distance between piers, the form had to be tilted in raising.



Cross-Section



Elevation

FORMS RAISED FIRST, THEN USED TO ERECT OWN SUPPORTING FALSEWORK

In building some of the shorter span forms, the 1 x 8-in. diagonals were dispensed with. When all the forms for one span were placed in position the floor joists were placed to tie the deck together, and a single post was put in position under the middle of each girder to take care of the deflection. The diagonal braces between girders were next put in place, which gave the entire superstructure great stiffness.

Just before concreting the span, the supporting posts were erected. This was done by means of a hand-line from the deck. The posts were, for the most part, doubled 2 x 6's with a 4 x 4-in. cap at the top, and were easily handled. When erected they were fastened at the top by a nail through the girder bottom. After all posts were in place the form was brought to exact grade by wedges driven at the bottoms of the posts. The lateral and diagonal braces were then placed on the falsework and the floor lagging placed on the deck. After being wired the forms were ready to receive concrete.

The weight of the largest forms was approximately 1600 lb., and when in place they deflected about a foot at the middle. Longer forms than the one shown were handled from the deck. These, however, were for one face of a girder only. The largest of these was 70 ft. long and 5 ft. wide, built of 2 x 4's with 1-in. lagging. They were handled by two small jibs operating at the quarter points, lateral stiffness being given by hand-lines at each end.

LIME RECLAMATION at the Columbus softening and purification works is being experimented with on a large scale. Charles P. Hoover, chemist in charge, has installed a $1000 plant consisting of a thickener, dewaterer and a rotary kiln, 20 ft. long and 3 ft. in diameter.

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

Continued Slides Make Time of Panama Canal Opening Uncertain

A cablegram dated Oct. 12 has been received by Major F. C. Boggs, at Washington, from the Governor of the Panama Canal, advising that continued movements of sliding material make it impossible to predict any approximate date of re-opening the canal. The dispatch said:

"Mass of material involved in the break of Oct. 14, 1914, which had been sliding gradually into prism, moved precipitately. This, combined with a similar movement from the break which occurred just opposite on the west bank in August, causes present conditions.

"Length of channel involved 1300 ft., of which 200 ft. has present width of 25 ft. and depth of 3 to 15 ft.

"For week ending Oct. 9, 209,000 cu. yd. of material were dredged, but as the movement continued the result has been to maintain only what slides left in the first instance. Canal is therefore physically closed temporarily.

"On the east side the bank is upward of 300 ft. above canal level, and on the west side varies from 300 to 400 ft. above. Material, in settling and moving, creates earth waves with deep depressions behind, those being some 500 to 600 ft. from the canal prism, with elevations of 60 to 80 ft. above water surface.

"These waves undoubtedly counterbalance the weight of the broken mass on either side, and, when removed, may cause another similar movement; hence the impossibility of making any prediction as to the date of reopening until after the waves which now block the channel have been removed and the action of the remaining material determined. Heavy rains materially affect the movement.

"Whether light draft ships can pass in advance of 30-ft. draft ships must depend on conditions when a reasonably secure channel is attained."

Four Thousand Take Part in Dedication of Arrowrock Dam

The great interest shown in Arrowrock Dam, near Boise, Idaho, completion of which was noted in this journal last week, was manifested by the fact that 4000 visitors took part in the formal dedication held, Oct. 4. Governor Alexander of Idaho in an address classed the structure as one of four great engineering achievements—the Panama Canal, the Panama-Pacific International Exposition, the Dalles-Celilo Canal and Arrowrock Dam—completed in the present year, and added that, with the exception of the Panama Canal, it represented the largest expenditure made by the National Government during the last six years.

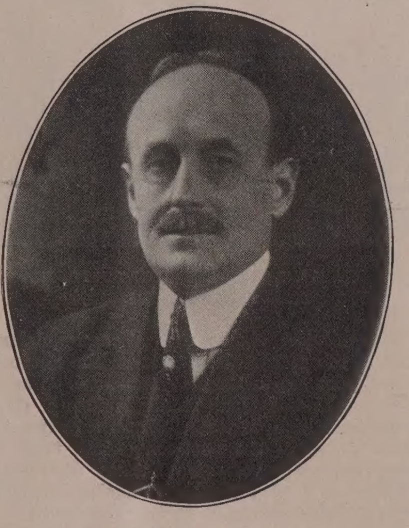
D. R. Hubbard, president of the Water Users' Association, paid glowing tribute to F. E. Weymouth, supervising engineer, U. S. Reclamation Service, Charles H. Paul, construction engineer, and James Munn, superintendent of construction, who had charge of the work, and all of whom were present at the ceremonies. J. H. Lowell, first president of the Water Users' Association, who was instrumental in the launching of the project gave a brief outline of its history.

The dam was completed nearly two years ahead of time at a saving of more than $2,500,000 on the original estimate. According to figures furnished by Charles H. Paul, the total amount of concrete reached 610,600 cu. yd., instead of 530,000 cu. yd., as stated in last week's issue. The excavation amounted to 683,000 cu. yd. The height of the dam from the lowest point of the foundation to the top of the parapet is 348.5 ft. Its length at the top is 1100 ft. and its width at that point 16 ft. At the base it is 240 ft. thick. Excavation was carried 90 ft. below the river bed to solid granite. The area of the foundation is about 1 acre. The reservoir has a capacity of 79,600,000,000 gal. Work on the excavation was started in July, 1910.

Baltimore's New Chief Engineer

Calvin W. Hendrick, whose appointment as chief engineer of the city of Baltimore was announced in these columns last week, enters upon his new duties with a very intimate knowledge of local public works. In fact, it was under his direction, as chief engineer of the Sewerage Commission, that the city's most important improvements, including the comprehensive system of sewers, the treatment works on the Back River and the huge pumping station, have been constructed and placed in successful operation. Mr. Hendrick has manifested his interest in the physical betterment of Baltimore in many other ways. One of his most notable works, perhaps, was the conversion of Jones Falls, a filthy sewage-laden stream which had been an eye-sore for years, into a covered concrete conduit supporting an imposing boulevard. This single piece of construction was of immeasurable benefit to the city, for it not only removed a nuisance but effected a large increase in property values in the vicinity. The Jones Falls improvement is described in the Engineering Record of May 1, page 544.

Leaves Sewerage Commission to Become Chief Engineer of City of Baltimore



CALVIN W. HENDRICK

Mr. Hendrick has always been a firm believer in letting the people know about the city's engineering work and as a result of his policy it is safe to say that in no city has the public a better appreciation of the value of the engineer in civic improvement than in Baltimore. His promotion to his present position of larger responsibilities is an unmistakable mark of the appreciation in which his former work is held. Now that the sewerage system and disposal works are completed Mr. Hendrick's responsibilities in connection with that improvement have been greatly lessened and he will have time to devote to his new duties.

Road Officials Gather at Cedar Rapids, Iowa

Second Northwestern Road Congress Has Attendance of About 500 at Three-Day Session to Discuss Highway Problems

About 500 men interested in all phases of the road problem attended the second annual convention of the Northwestern Road Congress, held at Cedar Rapids, Iowa, Oct. 4 to 7. Delegates were present from Illinois, Indiana, Michigan, Wisconsin, Iowa, Missouri, Minnesota, and North and South Dakota.

The program, as published in Engineering Record of Sept. 11, page 339, was carried out. The Wisconsin, Iowa, and Minnesota Highway Commissions, and Milwaukee County, Wis., as well as twenty-seven manufacturers of road equipment and material, had exhibits.

A feature of the program to those interested in ways and means for awakening a community to a keen desire for good roads was a paper by J. P. Clarkson, of Jasper County, Missouri. Mr. Clarkson had a message worth while and he delivered it. H. J. Kuelling, Milwaukee county highway commissioner, gave a brief but valuable talk on concrete roads. The paper read by Rodney L. Bell, division engineer of the Illinois Highway commission, was published in abstract in the Engineering Record of Oct. 9, page 453.

Officers elected for the ensuing year are as follows: President, John Hazelwood of Wisconsin; first vice-president, A. D. Gash of Illinois; second vice-president, J. H. Mullen of Minnesota; third vice-president, F. W. Buffum of Missouri, and secretary-treasurer J. L. Long of Iowa. A board of directors composed of S. A. Bradt of Illinois; A. R. Hirst of Wisconsin; T. H. McDonald of Iowa; T. S. Brown of North Dakota; W. R. Phillips of South Dakota; J. P. Clarkson of Missouri; H. M. Johnson of Michigan, and W. B. Neuman of Indiana, was elected. Detroit, Chicago and Minneapolis presented their claims for the next convention. Decision rests with the board of directors.

Exhibit Shows New Yorkers How Their Streets Are Cleaned

The New York Department of Street Cleaning initiated last year an exhibition of street-cleaning apparatus and appliances which was so successful that a second exhibit was staged this week. The parade on Tuesday was the finest in the Department's history, and included the twelve new 10-ton motor trucks with their various tractor appliances that are to be used in the "model district" between Fourteenth Street and Forty-second Street from Sixth Avenue to the Hudson River.

The exhibit, held at the First Field Artillery Armory, Broadway and Sixty-eighth Street, contains the latest developments in all street-cleaning appliances, snow plows, dumping trucks, sand spreaders, oil sprinklers, etc. Many firms from all over the country have sent their most efficient apparatus for inspection and comparison. The Department has organized a series of tests under actual service conditions—flushers on Wednesday, sweepers on Thursday and the various conveyances and carts on Friday. A model of the covered dump for delivering refuse to scows, described in the Engineering Record of Sept. 11, page 315, is exhibited. Many colored posters submitted by public school pupils in competition for prizes offered by the Department form an interesting feature of the exhibits, and illustrate a promising method of arousing general interest on the part of the public. Moving pictures of street cleaning, police and fire-fighting activities in New York City are shown in the evenings.

A meeting of the many officials present from the various cities in both this country and Canada convened on Friday morning for the purpose of forming a Street Cleaning League to organize annual parades and exhibitions, and for interchange of new ideas on the most economical and efficient methods and appliances for keeping cities clean. John T. Fetherston, street cleaning commissioner of New York City, has been active in initiating this movement. J. R. Buchanan is director of the exhibition.

Court Upholds Present Water Rates in Denver

No reduction in water rates will take place in Denver. The Federal District Court last week fixed the value of the property of the Denver Union Water Company at $13,415,899, a figure which will not permit the lowering by 21 per cent asked for by the city. The findings sustain the present rates and in effect confirm the title of the company to its water rights. It also puts an end to the foundation for the idea of the city building a competing plant and seizing the company's water without compensation.

Prominent engineers representing the city and company brought in a valuation of $14,400,000 a few years ago. The present valuation excludes from the rating base branches of considerable value independent of use for the city supply. The principal items of the present valuation are: Distribution system, $3,450,000; water rights, $2,950,000; Cheeseman dam, $1,121,000; Platte Canyon conduits and filters, $2,410,000; 8400 acres of land around dam, $638,000. The amount of preferred and common stock is $7,500,000, and of bonds, $12,000,000.

Florida's Road Department Formed

The State Road Department of Florida, which was created by a recent act of the Legislature, has become an actuality by the appointment of the five members that constitute it by Governor Trammell. Those appointed are: F. O. Miller, president of the Florida State Good Roads Association; Edward Scott, civil and highway engineer, of De Soto County; W. J. Hillman, honorary president of the Florida State Good Roads Association; J. D. Smith, banker, of Marianna, and M. M. Smith, banker, of Orlando.

The members of the department receive no compensation other than the expenses incurred in the performance of their duties. Headquarters will be at the State Capitol at Tallahassee. The duties of the department are to collect data and information as to all the roads in the State and, where practical, to have maps made; to investigate and gather information as to suitable material for road building in the different localities in the State; to furnish information free to county commissioners, and to supervise the methods and expenditures of the various counties.

The department will appoint a salaried State road commissioner and such assistants and clerical employees as are necessary. The commissioner and his assistants will visit and inspect the roads in the different counties and furnish technical advice and assistance without expense to such counties, except for traveling.

Ashland, Wis., to Have $3,000,000 Concrete Ore Dock

The heavy demand for iron is said to have hastened action in regard to the construction of a $3,000,000 concrete ore dock at Ashland, Wis. Plans for the new dock have been completed and work will be started in time to have the structure ready for navigation when the season opens next spring. The present dock will be torn down as soon as navigation is over for 1915.

Another Step in the Procedure to Widen Twelfth Street, Chicago

Legality of the Chicago city ordinance calling for the widening of Twelfth Street from Michigan Avenue to Ashland Avenue, it is expected, will be decided shortly by the Superior court. This is the last step before the actual trial of the case, which will determine the awards to be made to property owners whose property is taken and the assessments of those owners who will be benefited by the public improvement. The awards to be distributed to property owners total $3,056,144, and are estimated on the proposed widening of the south side of Twelfth Street 68 ft. from Michigan Avenue to State Street; 52 ft. from State to Canal Street and 42 ft. from Canal Street to Ashland Avenue. Actual work it is thought will be started in about 8 months.

Markers Placed for the Post-Convention Trip

As mentioned editorially in this journal on Sept. 25, the arrangements made by the San Francisco local committee for the post-convention trip of the American Society of Civil Engineers were most complete. The accompanying view shows the mileage marker at one of the points of interest on the automobile road from Santa Cruz to San José. The view does not show the small lettering on the marker, which indicated that its purpose was as a guide in the post-convention trip. The accompanying view was taken by Lazarus White of Smith, Hauser & McIsaacs of New York. Mrs. White is in the rear seat.

MILEAGE MARKERS ON ROUTE OF POST-CONVENTION TRIP, SAN FRANCISCO

Efficiency Society in Convention Taboos "Red-Tape"

At its third annual fall convention, held at the Lake Placid Club, Essex County, N. Y., Sept. 17-19, the Efficiency Society voiced a protest against "red-tape" masquerading under the convenient disguise of "system" and advocated strongly the promotion of efficient citizenship involving some form of compulsory military service.

While many of the papers were of particular concern to the production engineer, shop superintendent or manager of works, there were several also which were of interest to the office man, be he interested in engineering drafting, design, estimates or investigation. Of especial interest to engineers were two papers, one dealing with the abuse of "system" and one upon efficient citizenship.

The former was by John Calder, entitled, "System and Its Abuse." The author, himself a long-time advocate of efficient system, pointed out the danger of cumbersome red-tape which destroys its usefulness and the business which it hopes to benefit. While a certain amount of system is desirable in all ventures he pointed out that it should never cost more than the savings or earnings secured by its use. The lack of earning value of records which are not made promptly available as guides to future operations was noted and the distinction between those methods which relate to routine operations, and those which aid in increasing the output and enlarging the opportunities of the business were pointed out.

He advocates a scientific study of all facts connected with any enterprise as the basis of any system and urges the sympathetic co-operation of all affected by its operation, both executive and employe, if best results are to be secured, rather than the arbitrary enforcement of any rigid requirements without possibility of alteration or amendment.

The other paper was by Mr. Miles M. Dawson, consulting actuary of New York, entitled, the "Promotion of Efficient Citizenship." It was pointed out that one of the serious drawbacks was that we have been gaging the efficiency of the individual from the standpoint of service to himself and not from that of service to others.

One of the most difficult qualities for any American to acquire Mr. Dawson said, is efficient citizenship and this point of view, after all, should particularly appeal to the engineer. Because of his training and habits of thought he should analyze closely all results and not be led astray by fulsome phrases.

It was the interest in citizenship in general and all matters of governmental function, many of the wastes of which are particularly well known to the engineer, upon which stress was laid by the author. How we have encumbered ourselves with bureaus and commissions and check legislative functions instead of concentrating duty and authority in the few. But of even more accute concern to the engineer, in these days of discussion of military preparedness, was the consideration of the wisdom and helpfulness of obligatory military service in the promotion, first, of the individual efficiency, and, second, of National efficiency.

Road Men Would Spend $10,000,000 for Illinois Cross-State Roads

Several down State road organizations have asked Governor Dunne of Illinois that he include in the call for a special session of the Legislature (should such action be necessary) a proposition for issuing $10,000,000 in State bonds for constructing a north and south and two east and west roads across the State. No action has been taken in the matter, because it has not been definitely decided to call a special session of the Legislature.

The State Highway Commission has been using its influence to interest the various counties in the county bond issues for building the designated State-aid roads. The new law passed at the last session of the Legislature made it possible for the counties to use their regular allotments of State-aid money for paying off one-half of the cost of construction of bond-issue roads and turning them over to the State for maintenance. It is believed that the commission would prefer to see roads built in this manner rather than by a State bond issue.

However, the matter has never been acted upon by the State Highway Commission and it is possible they would get behind such a movement as that proposed if it were properly launched and some provision were made for defraying the necessary inspection, engineering and administrative expenses connected therewith, as the appropriations are now totally inadequate to handle such a matter.

Washington Levies $2,578,193 in Taxes for Highway Purposes

The State Board of Equalization of Washington has levied taxes amounting to $2,578,193, payable by counties next year, for highway purposes. The total is made up of $1,031,277 for highways to be constructed under the supervision of the State Highway Department on previously located routes and $1,546,916 for paved surface or gravel permanent roads to be constructed under the direct supervision of counties.

News of Engineering Societies

The Engineers' Society of Western Pennsylvania will hold a meeting in the society rooms in the Oliver Building, Pittsburgh, Oct. 19. Willis Whited, bridge engineer of the Pennsylvania State Highway Department, will speak on "The Mathematical Treatment of the Elastic Arch." At a meeting of the structural section to be held Nov. 2, Prof. Charlees M. Spofford of the Massachusetts Institute of Technology, will speak on "Highway Floors."

The Colorado Association of Members of the American Society of Civil Engineers was addressed Oct. 9 by S. B. Williamson, chief of construction, U. S. Reclamation Service, on "The Reorganization of the Reclamation Service and Its Purpose." The newly elected officers of this association are: John E. Field, president; Roger W. Toll, vice-president, and L. R. Hinman, secretary-treasurer.

The Chicago Association of Commerce, Engineers' Division, resumed its by-monthly meetings Oct. 8 with an informal address by Prof. F. H. Newell on the welfare of the engineer. Following his talk suggestion was made to offer a cash prize to engineering students for the best paper on a proper method of diffusing engineering information to the layman public. The association will be asked for $100 for the prizes, a proposition Edmund T. Perkins, chairman of the division, was of the opinion the association would gladly foster.

Personal Notes

J. J. Rockwell has rejoined the staff of the McGraw Publishing Company in the capacity of advertising counsellor to the company and its customers, and will make his headquarters at the company's general offices in New York. Since Mr. Rockwell's previous association with the McGraw Publishing Company (during the years 1910 and 1911) he has been engaged in the advertising agency business in Chicago in connection with the Crosby-Chicago Advertising Agency. In earlier years he was associated with the Mahin Advertising Company and the Long-Critchfield Corporation, both well known advertising agencies in Chicago, and is well known in advertising circles throughout the country. His work as an advertising expert has frequently excited highly favorable comment and his long experience in the general agency business, as advertising manager in publishing fields and as counsellor for advertisers in many lines of business, with his special and unusual experience in industrial and technical fields should enable him to be of peculiarly valuable service to the Engineering Record and its customers.

T. McLean Jasper, formerly secretary to the Chicago City Waste Commission, and previous to that assistant engineer with Alvord & Burdick, has been given a commission in the Royal Field Artillery, England, in charge of a battery. He has been in the artillery training camp at Salisbury since July. As each battery is given about six months' training, he will probably not be sent to the Continent before Christmas.

F. R. Judd, assistant engineer in the bridge and building department of the Illinois Central Railroad, has been appointed engineer of buildings. Mr. Judd has been, with the exception of a few months, continuously in the service of the Illinois Central for the last sixteen years.

C. C. Westfall, assistant engineer in the bridge and building department of the Illinois Central Railroad, has been appointed engineer of bridges. Mr. Westfall was graduated from the University of Illinois in 1907. With the exception of eight months, when he was in North Dakota as chief engineer of the Midland Continental Railroad, he has been connected with the Illinois Central since that year.

Maro Johnson, heretofore engineer of bridges and buildings of the Illinois Central Railroad, has been detailed on special work by that railroad and the bridge and building department split into separate departments, the new heads of which are noted elsewhere in these columns.

Ralph Hilscher, assistant engineer with the State Water Survey, University of Illinois, has resigned to join the staff of C. G. Gillespie, director of the bureau of sanitary engineering of the California State Board of Health. Mr. Hilscher was graduated from Massachusetts Institute of Technology.

Victor R. Walling has been appointed principal assistant engineer of the Chicago & Western Indiana Railroad Company in charge of construction and maintenance. He was graduated from Kansas University in 1901 and from that year until 1912 was with the Greene Cananea Copper Company, except for a short term with the Southern Pacific. With the copper company he rose from draftsman to first assistant engineer and superintendent in charge of railroad, maintenance and operation and mill and smelter construction.

Jay Rossiter, assistant engineer in the Chicago water pipe extension division of the bureau of water, has been made engineer of the division of track elevation. Since leaving the Armour Institute of Technology, where he received his professional education, he has been connected with the Chicago city engineer's office continuously, except for a 2-year period of service in the Philippines as assistant engineer for the Bureau of Public Works and 1 year as a contractor's general superintendent of construction on the Algoma Central Railroad in Canada. For a year previous to his going to Armour Institute he was in the engineers' corps of the Illinois Central Railroad Company.

Holbert W. Fear, formerly junior engineer in the water resources branch of the U. S. Geological Survey, has been appointed to a similar position on the forces of the New York Public Service Commission, First District.

D. M. Cook, formerly connected with the Detroit Edison Company appraisal work, has been appointed inspector on concrete bridge and pavement work and sewer construction for Windes & Marsh at Winnetka, Ill. In the near future he will be appointed assistant to the village manager.

Edward Scott, civil and highway engineer of Arcadia, Fla., has been appointed a member of the recently created State Road Department.

C. H. Vaughan, formerly second vice-president and chief engineer of the Penn Bridge Company of Beaver Falls, Pa.; H. R. Hortenstine, formerly contracting manager of that company, and J. O. Childers, who had charge of the erection of the Panama Canal lock gates for the McClintic-Marshall Construction Company, have purchased the plant and assets of the York Bridge Company of York, Pa., and will operate under the name of the York Bridge & Construction Company. It is expected that the plant, which has a capacity of about 7000 tons per year, will be ready to operate next month, after which time the company will engage in the manufacture and erection of steel bridges, buildings, lock gates, coal tipples and breakers, and all kinds of structural steel work.

John T. Whistler, who has been with the Reclamation Service, with headquarters at Portland, Ore., since 1905, has been appointed engineer on the International Boundary Waters Commission, the body that settles disputes regarding authority over waterways on the Canadian border. Mr. Whistler was in charge of the Umatilla project for the United States Government, and since the completion of that work has devoted his time to other Government irrigation interests in Oregon.

Wixsom & Coghlin, contractors for sewers and pavements, have opened an office in the Spitzer Building, Toledo, Ohio. Mr. Wixsom has been in municipal contracting for twenty years, with headquarters at North Baltimore, Ohio, and Mr. Coghlin has been engaged in private enterprises developing real estate additions in the South.

D. W. Cole, project manager of the Truckee-Carson project at Fallon, Nev., for the past 5 years, is leaving the Reclamation Service to attend to personal interests. The Lower Carson storage dam, later known as the Lahontan dam, was constructed during Mr. Cole's term of service, designs having been prepared in the project office in the fall of 1910. The dam was completed June 30, 1915, and the cost is said to have been $100,000 less than the estimated cost, which was approximately $1,530,000. Mr. Cole was instrumental in securing Government control of the Lake Tahoe outlet by supplying the necessary engineering data for bringing about a satisfactory settlement, the case being tried by the U. S. District Court at San Francisco and made final on June 28 upon payment to the Truckee River General Electric Company of the stipulated value of the condemned property.

R. S. Rankin, formerly connected with the U. S. Steel Corporation on the design of new works at Duluth, has been engaged by the city of Minneapolis to carry on the leakage survey of the municipal waterworks recommended by F. W. Cappelen, city engineer, as was noted on page 399 of the Sept. 25 issue of this journal. Mr. Rankin, who is a graduate of the University of Minnesota, is already familiar with the Minneapolis waterworks system, having been two years in the city's employ on the construction of the new filtration plant, previous to his engagement with the steel corporation.

Edward J. Ducey, formerly junior highway engineer with the U. S. Office of Public Roads and instructor in civil engineering at the Georgia School of Technology in charge of highway work, has been appointed instructor in civil engineering at Pennsylvania State College.

A. H. Davison, formerly chief of party in charge of field engineering and layout of power canal and new concrete dam for the Turners Falls Power & Electric Company, Turners Falls, Mass., has been appointed junior engineer, water resources branch, U. S. Geological Survey.

J. Frank Bowen has been reappointed superintendent of highways and city engineer of the town of Manchester, Conn.

H. G. Overholt, formerly engaged in contracting in southern Minnesota under the firm name of Minnesota Concrete Engineering Company, has been appointed assistant superintendent on the construction of a large reinforced-concrete factory building at Oklahoma City. Previous to entering the contracting business, Mr. Overholt was connected with the engineering department of the Chicago, Milwaukee & St. Paul Railway.

L. M. Mitchell, formerly inspector on the concrete viaduct being constructed jointly by the Chicago & Northwestern Railroad and the Minneapolis & St. Louis, has been transferred to Oskaloosa, Iowa.

Blake Taylor, formerly special district road engineer in charge of road construction in Wetzel County, W. Va., has been retained to take charge of the street improvements about to be made at Berkly Springs, W. Va.

Harold M. Lewis, formerly resident engineer on the construction of a sewage system and waterworks extensions at Charleston, Mo., is now in the office of Charles W. Leavitt, civil and landscape engineer, 220 Broadway, New York City. Up to the outbreak of the European war Mr. Lewis was on the staff of the Emscher Genossenschaft at Essen, Germany.

L. A. Boulay, consulting engineer of Toledo, Ohio, and formerly a member of the firm of Smith & Boulay of that city, has been appointed county sanitary engineer of Lucas County, Ohio.

W. C. Spencer, formerly resident engineer on concrete road construction for the Orange County (Cal.) Highway Commission, has been appointed resident engineer on the same class of work for the highway commission of Riverside County.

L. Pertsov has joined the staff of I. F. Stein, consulting engineer, Old Colony Building, Chicago.

D. C. Sherman, formerly structural engineer with the Morris Sherman Company of Chattanooga, has been appointed structural engineer for the J. E. Moss Iron Works of Wheeling, W. Va.

Lloyd Runkle has been appointed city engineer of Tiffin, Ohio.

Benito R. Ordonez, formerly draftsman with the Burr Company of Champaign, Ill., has been appointed research fellow in the engineering experiment station, department of railway engineering, at the University of Illinois.

J. L. Jacobs, formerly engineer in charge of the Municipal Efficiency Division of Chicago, has opened offices in the Monadnock Block, Chicago, to engage in consulting practice, specializing in service and efficiency surveys, management, appraisals and cost accounting, either for industrial or public institutions. He was graduated from Sheffield Scientific School, Yale University, in 1907, and remained in New Haven, engaged in graduate work and city surveying and examinations of buildings until 1908, when he became assistant engineer with J. A. Kirby & Sons, civil engineers and surveyors, of Port Chester, N. Y., on municipal and sanitary engineering work. In 1909 he was appointed designer and detailer of concrete constructions in the bridge and building department of the Chicago, Milwaukee & St. Paul Railway He left this work in 1911 to accept an appointment with the Civil Service Commission of Chicago, assisting in investigations of conditions of employment, organization, management and systems used in city departments. He was appointed engineer in charge of the efficiency division in 1911.

H. K. McCay, formerly city engineer of Baltimore, has been appointed harbor engineer of that city.

C. S. Sale, formerly editor for the Chicago association of the commerce committee of investigations on smoke abatement and electrification of railway terminals, has been appointed assistant to the director of the engineering experiment station and instructor in civil engineering at the University of Illinois. He was graduated from Purdue University in 1906 and served as assistant engineer on the Florida East Coast Railway from that date until 1907, when he was appointed associate editor on the *Railway Age Gazette.* In 1909 he became sales manager of the Blount Plough Works of Evansville, Ind., and in 1910 became connected with the Municipal Engineering Company at Indianapolis. He was appointed editor for the Chicago association of the commerce committee in 1913.

Fred L. Weeks, formerly assistant engineer, maintenance-of-way of the Great Northern Railway at St. Paul, has been appointed computer on the forces of the Interstate Commerce Commission, Division of Valuation, at Kansas City Mr. Weeks was graduated from Sheffield Scientific School, Yale University, in 1911 and has been in the employ of the Great Northern from that date until the present appointment.

Frank L. Herbert, cashier and purchaser of the Bowers Southern Dredging Company of Galveston, has been transferred from Norfolk, Va., on the completion of the company's work at that city, to Miami, Fla.

Camillo Weiss, formerly connected with the Guerber Engineering Company of Bethlehem, Pa., has been appointed research fellow in the engineering experiment station, department of civil engineering, at the University of Illinois.

Steller Engineering Company, engineers and contractors, Loan & Trust Building, Milwaukee, has been retained to prepare plans and specifications for the proposed waterworks and sewerage system for Pulaski, Wis.

Frank Allen Kirkpatrick, who for the past year has been doing research work in ceramics at the University of Illinois, has been appointed research fellow in the engineering experiment station, department of ceramic engineering, at that university.

L. A. Pockman of San Francisco has been appointed safety engineer of construction for service with the safety department of the industrial accident commission in Los Angeles, Cal. Mr. Pockman will have under his supervision the safety of men employed in sewer construction and similar work.

Frank Bachmann, formerly of the Illinois State Water Survey and for the past five years assistant chemist and bacteriologist at the sewage testing station of the Sanitary District of Chicago, has been appointed analyst of the sanitary division of the California State Board of Health, with headquarters at Berkeley, Cal.

Obituary Notes

Henry C. Shaw, vice-president of the A. Garrison Foundry Company, died Sept. 27. He was born in Pittsburgh in 1854 and was graduated in civil engineering at Rensselaer Polytechnic Institute.

Thomas Hovenden, general superintendent for W. W. Lindsay & Company, engineers and contractors, of Philadelphia, died at Plymouth Meeting, Pa., Sept. 19. He was born in 1882 and was graduated from the University of Pennsylvania in 1903. His first engineering work was as assistant on the engineering forces of the maintenance-of-way department of the Baltimore & Ohio Railroad. In 1904 he was with the Latta & Terry Construction Company on the location and construction of the concrete seawall at the U. S. Naval Academy, Annapolis, Md. From this work he went to the University of Pennsylvania as instructor in civil engineering. He became connected with W. W. Lindsay & Company in 1905 and remained in that company's service continuously.

Thomas P. Fowler, former president of the New York, Ontario & Western Railway, died Oct. 12 at his home at Warwick, N. Y.

A. S. F. Berquist, civil engineer and inventor of the Berquist patent suspension bunker for storing coal, ore and similar materials, died in New York City Oct. 7. He was born in Sweden in 1863 and came to the United States in 1886, after being graduated from the University of Lund, Sweden. His first engagement in this country was with the Baldwin Locomotive Works, where he remained until 1892. For the next five years he served as chief draftsman and engineer in the construction department of the Spreckles Sugar Refining Company at Philadelphia on the erection of warehouses, pier sheds and overhead tracks for trolley operations. While engineer for the American Coffee Company in Brooklyn, N. Y., from 1897 to 1900, he invented the suspension bunker which bears his name. After this engagement he served as assistant engineer for the Rapid Transit Subway Construction Company of New York City in charge of metal structures and steel erection. At the time of his death he was chief engineer for the Berquist Patent Suspension Bunker Company of Brooklyn.

Civil Service Examinations

United States.—An open competitive examination for surveyors and transitmen in the General Land Office will be held, Dec. 8 and 9, at the usual cities throughout the country. The salaries for these positions are stated to be from $100 to $110 a month, for transitmen, and from $125 to $150 a month for surveyors. Applicants must be 19 years or older and should have specific knowledge in mathematics and surveying. Forms (1312) may be secured by addressing the United States Civil Service Commission at Washington, or any of the civil service boards at the principal cities and stating the title of the examination for which the form is desired.

Massachusetts.—An examination for the position of investigator and examiner, highway commission, at a salary of from $1,200 to $1,500 a year, will be held Oct. 28. Candidates competing for this position must have experience and training in the construction and operation of automobiles in their relation to public highways. Application blank, which must be on file Oct. 20, may be secured from the Civil Service Commission, Room 151, State House, Boston.

Another competitive examination for sanitary engineers will be held in Boston Dec. 6, open to residents of the State. Application form (No. 1), which may be secured from the Civil Service Commission, State House, Boston, should be sent to the commission's office at once, for a notice to appear at the examination will not be sent to those who have failed to have their forms on file at least ten days previous to the examination.

New Jersey.—The Board of Health announces that an examination for assistant sanitary engineers to fill several vacancies in the engineering corps of the department will be held on Nov. 10. The examination is open to residents of the State. Those who are interested should communicate immediately with Gardner Colby, New Jersey State Civil Service Commission, State House, Trenton.

New York.—An examination for an engineering draftsman, salary from $1,201 to $1,500, will be held on Oct. 30. Candidates must be at least 21 years of age and must have had two years' experience. The examination is open to non-residents of the State, who, however, are subject to the provision that in case the eligible list contains the names of three or more residents these shall be preferred. Application blanks must be on file by Oct. 20, and no blank will be mailed after Oct. 18. Further information may be secured by applying to the State Civil Service Commission, Albany, N. Y., stating the position for which the information is desired.

California.—The State Civil Service Commission announces the following examinations open to residents of the State:

Civil Engineer, Grade 4, salary from $200 to $300 a month, to be held Nov. 13. Applicants must have had at least 10 years' experience in engineering work, part of which should have been relative to highway construction. Following this examination will be an oral interview by which the eligibility of the applicant will be predicated.

Engineering Draftsman, Grade 2, salary from $1,200 to $1,800 a year, to be held Nov. 26-27, forms to be on file Nov. 20. Applicants must be 21 years old or over and must have at least two years' experience.

Mechanical Engineering Draftsman, salary from $1,200 to $1,800 a year, to be held Dec. 10-11, forms to be on file Dec. 4. Applicants must be 21 years old and must have had two years' experience.

Candidates for these positions should apply now for application forms and other information to the Civil Service Commission, Forum Building, Sacramento; Ferry Building, San Francisco, or Hall of Records, Los Angeles.